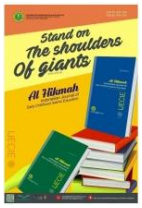
AL HIKMAH: INDONESIAN JOURNAL OF EARLY CHILDHOOD ISLAMIC EDUCATION
ISSN (P): 2550-2200, ISSN (E): 2550-1100,
VOL. 9 (2), 2025, PP. 374 – 388
https://journal.uaindonesia.ac.id/index.php/ijecie



The Evolution of Data Collection Techniques in Early Childhood Education Management Research: A Literature Review

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ARTICLE INFO

Article history:
Received June 17, 2025
Revised September 15, 2025
Accepted October 25, 2025
Available online December 31, 2025

Keywords:
Data Collection, Early Childhood Education Management, Learning Analytics, Educational Technology.

ABSTRACT

This study examines the evolution of data collection techniques in Early Childhood Education management, which represents a major challenge in enhancing the quality of monitoring and evidence-based decision-making. The purpose of this research is to analyze the development of methods, instruments, and technology integration in data collection practices, as well as to identify existing gaps. The method employed is a literature review of recent scientific studies on both traditional and modern data collection techniques, including manual observation, interviews, questionnaires, learning analytics, big data, and artificial intelligence integration. The findings indicate that although traditional methods remain dominant, modern technologies enable real-time monitoring of child development, predictive analysis, and personalized pedagogical interventions. The core discussion emphasizes the importance of combining traditional and modern methods, teacher training in data literacy, and implementing data privacy and security policies to enhance the validity, reliability, and relevance of information. In conclusion, technology adoption must involve active stakeholder engagement and strengthening human resource capacity to ensure an effective transition toward data-driven educational management. This study contributes to the development of Early Childhood Education management practices by providing a theoretical framework and practical recommendations to optimize data collection, support evidence-based decision-making, and strengthen evaluation and innovation in early childhood education.

INTRODUCTION

Early Childhood Education (ECE) serves as a critical foundation for the holistic development of children, encompassing cognitive, social, emotional, and even physical growth. The early years of a child's life are particularly sensitive periods in which learning experiences can significantly shape neurological, behavioral, and emotional development. Research has consistently shown that high-quality early education positively correlates with improved academic performance, social skills, and long-term educational outcomes (Bahrani et al., 2025; Damayanti et al., 2025). The quality of educational management at the ECE level, therefore, is not merely an administrative concern but a central determinant of children's learning outcomes and readiness for subsequent educational stages. Effective management practices in ECE involve careful planning, monitoring, and evaluation of educational processes, all of which rely heavily on accurate, reliable, and timely data collection.

An ideal ECE management system is characterized by its ability to implement accurate, evidence-based, and responsive data collection processes. Such systems ensure that both teachers and administrators can make informed decisions that address the developmental needs of children and the operational requirements of the educational institution. Evidence-based management allows educators to identify areas where children require additional support, tailor curriculum strategies to individual or group needs, and allocate resources more efficiently. For instance, monitoring children's fine motor skills, language acquisition, or socio-emotional behavior through structured observation and digital tools enables administrators to detect patterns and intervene appropriately before developmental gaps widen. With the advent of modern technology, including learning analytics, big data, and artificial intelligence, the potential for data-driven decision-making in ECE has expanded considerably (Alfredo et al., 2023; Suhardi, 2025). Technology not only improves the accuracy of data collection but also facilitates the synthesis of complex datasets, making it easier for administrators to monitor performance trends, evaluate program effectiveness, and plan interventions strategically.

Despite these advantages, the current state of data collection in ECE faces several significant challenges. Many institutions continue to rely on traditional methods such as manual observation, checklists, and daily record sheets. While these methods are useful for capturing qualitative insights, they are inherently prone to bias, inconsistency, and incomplete reporting (Aurilia et al., 2025; Maesaroh, 2025). Observations may be influenced by subjective interpretation, differences in teacher attentiveness, or even contextual factors such as classroom environment and child temperament. Additionally, manual record-keeping is time-consuming and limits the ability of administrators to perform longitudinal analysis or integrate data across multiple domains. These limitations hinder the optimal management of educational programs and reduce the accuracy of developmental assessments, which can ultimately affect children's learning trajectories.

Another major challenge relates to human resources and technical competencies. Teachers often lack formal training in data collection, analysis, and interpretation, which reduces the effectiveness of both traditional and technology-assisted approaches. Even when digital tools are available, insufficient training in using software for learning analytics or AI-based platforms prevents educators from fully leveraging these resources. Moreover, minimal integration of information technology within the institutional infrastructure further limits the potential for comprehensive, real-time monitoring of children's progress (Ilyas et al., 2025; Zhao et al., 2024). These challenges collectively impede the ability of ECE institutions to implement targeted educational programs, evaluate curriculum effectiveness, and support personalized learning interventions.

Previous research in primary and secondary education has explored a range of data collection techniques, including learning analytics, big data applications, and artificial intelligence, to enhance school management and predict student performance (Ersozlu et al., 2024; Noviandy et al., 2025; Sunarto et al., 2024). These studies have demonstrated the potential of integrating technology for real-time monitoring, predictive modeling, and performance evaluation. In addition, qualitative data collection strategies, such as semi-structured interviews, focus group discussions, and ethnographic observations, have been

employed to capture rich contextual information, particularly in policy implementation research (Aurilia et al., 2025). Such approaches provide nuanced insights into student experiences, teaching practices, and institutional challenges that are often overlooked in purely quantitative studies. However, much of this research has focused on primary and secondary education contexts, with relatively limited attention given to early childhood settings. Consequently, there is a critical gap in understanding how data collection techniques can be adapted and optimized specifically for ECE management.

Addressing this gap, recent literature emphasizes the integration of human-centered learning analytics and AI as a promising avenue to optimize educational data collection in ECE (Alfredo et al., 2023; Bulut et al., 2024; Fernández-Sánchez et al., 2025). Human-centered analytics focuses not only on aggregating data but also on contextualizing it in ways that prioritize the child's developmental needs, teacher practices, and classroom dynamics. For example, AI-powered dashboards can track individual children's engagement, language development, and socio-emotional interactions, providing teachers with actionable insights that inform personalized learning interventions. By combining qualitative observations with quantitative analytics, ECE administrators can gain a comprehensive understanding of learning processes, identify early indicators of developmental delays, and implement timely interventions. Additionally, AI-enabled predictive models allow institutions to anticipate learning challenges and design preemptive strategies, thus improving educational outcomes and program efficiency.

Moreover, digitalization and school transformation strategies are crucial for strengthening ECE management systems. Integrating technology into routine administrative and pedagogical processes can enhance teacher engagement, streamline data entry, and facilitate real-time monitoring and evaluation (Damayanti et al., 2025; Ilyas et al., 2025). For instance, cloud-based platforms enable centralized data storage and secure sharing of children's developmental records among teachers, administrators, and even parents, promoting collaboration and transparency. Digital tools also reduce administrative burden, allowing teachers to focus more on pedagogy and individualized attention rather than manual record-keeping. Such strategies align with broader trends in education management that prioritize efficiency, accountability, and evidence-based decision-making.

The present study aims to conduct a systematic literature review on the evolution of data collection techniques in ECE management research. Specifically, the study seeks to identify prevailing trends, methodological approaches, and innovative technologies applied in ECE data collection, while also highlighting existing gaps in practice and research. By synthesizing findings from multiple studies, this research provides a comprehensive overview of how data collection methods have evolved over time and how they can be adapted to meet contemporary demands in early childhood education. Furthermore, the review aims to offer practical guidance for ECE practitioners and policymakers seeking to implement data-driven management strategies that enhance educational quality and child development outcomes.

The anticipated benefits of this review are multi-faceted. First, it will improve understanding of effective data collection techniques in ECE, offering insights into the relative strengths and limitations of both traditional and technology-assisted methods. Second, it provides guidance for policymakers and educational practitioners in implementing

data-driven management strategies, such as integrating digital platforms, adopting AI analytics, and designing teacher training programs that build data literacy skills. Third, the review will offer recommendations for technology integration, including how to safely and ethically use digital tools while protecting children's privacy. Fourth, by evaluating the effectiveness of existing data collection methods, the study will help administrators make informed decisions regarding curriculum planning, resource allocation, and program evaluation. Ultimately, these contributions aim to improve the quality of decision-making and management practices in ECE institutions, ensuring that children receive developmentally appropriate, evidence-based education (Kasih & Muspawi, 2024; Latif & Zhai, 2025).

In conclusion, early childhood education represents a pivotal stage in human development, and the management of ECE institutions plays a crucial role in determining educational outcomes and readiness for future learning. Effective data collection techniques ranging from manual observation to sophisticated AI-based analytics are essential for monitoring development, planning interventions, and supporting evidence-based decision-making. While traditional methods remain relevant, particularly for capturing qualitative insights, they are limited by bias, inconsistency, and inefficiency. Modern digital and analytical approaches offer significant advantages, including real-time monitoring, predictive insights, and the potential for personalized interventions, but require investment in infrastructure, training, and ethical safeguards.

By systematically reviewing the evolution of data collection techniques in ECE, this study provides valuable insights and practical recommendations for educators, administrators, and policymakers. The findings aim to bridge the gap between traditional practices and emerging technological innovations, facilitating the implementation of integrated, evidence-based, and child-centered data management systems. Ultimately, the research not only contributes to academic knowledge but also provides actionable guidance for the practical enhancement of early childhood education, ensuring that children receive high-quality learning experiences that support their cognitive, social, and emotional development from the earliest stages of life.

METHODS

This study employs a qualitative research design with a literature review approach. This approach was selected because the purpose of the study is to review, analyze, and synthesize various studies conducted on data collection techniques in Early Childhood Education (ECE) management. A literature review enables the researcher to identify trends, methodological developments, technological innovations, and gaps in previous research without collecting primary data directly from the field. This design also allows for a systematic mapping of the evolution of data collection techniques, both in qualitative and quantitative contexts, as well as the integration of modern technologies such as learning analytics and artificial intelligence.

The population of this study includes all research related to ECE management and early childhood educational data collection published in scientific journals, conference articles, and international and national digital repositories over the past five years. The sample was selected purposively, including studies that explicitly discuss data collection techniques, educational management innovations, or the use of technology and analytics in the context of

ECE. Inclusion criteria comprised studies published from 2023 to 2025, available in English or Indonesian, and employing a clear methodology for data collection, whereas studies outside the context of early childhood education or focused on primary/secondary education management were excluded.

Data collection in this study was carried out through the identification, selection, and extraction of data from secondary literature. The data collection instrument consisted of a literature synthesis sheet, which contained information on: type of study, objectives, data collection methods, tools or technologies used, sample, key findings, and research gaps. This sheet was developed based on systematic review guidelines (Aurilia et al., 2025; Hamid, 2025) and was pilot-tested to ensure consistency in recording. Data were classified according to the type of collection method (observation, interviews, questionnaires, learning analytics, and big data), education level, and technology integration.

Data analysis was conducted using a thematic and qualitative descriptive approach, where each study was examined to identify trends, techniques, innovations, and challenges in data collection in ECE. The analysis process included: literature mapping, classification of data collection techniques, synthesis of methodological and technological developments, and identification of research gaps. The results of the analysis were presented in descriptive narratives, tables, and thematic charts illustrating the evolution of data collection techniques and potential technology-based solutions.

In the qualitative context, the researcher actively serves as an observer and literature analyst, performing critical interpretation of findings from previous studies. The subjects of the study are scientific publications related to ECE management, while the informants are indirect, consisting of authors and prior research that serve as data sources. Data mining techniques include searching academic databases (Scopus, Google Scholar, DOAJ), selecting articles according to inclusion criteria, data extraction, and thematic coding. The study is expected to take 3–4 months, covering literature search, selection, analysis, and report writing. Data validity is ensured through literature triangulation, peer review, and the use of credible primary and secondary sources (Kasih & Muspawi, 2024; Latif & Zhai, 2025).

With this research design, the study is expected to provide a comprehensive understanding of the evolution of data collection techniques in ECE management, present best practices, and identify technological innovations that can enhance the effectiveness of early childhood educational management.

RESULT

The evolution of data collection techniques in early childhood education management shows significant changes from traditional methods to more advanced approaches with technology integration. Based on the literature review, data collection techniques can be classified into several main categories: manual observation, interviews, questionnaires, learning analytics, and big data usage. Each category has distinct characteristics, advantages, limitations, and levels of technology integration (Ersozlu et al., 2024; Huong et al., 2024; Pulungan et al., 2025).

Manual Observation

Manual observation is the earliest data collection technique and is still widely used in PAUD institutions. This method involves direct observation of children's behaviors, interactions, and activities during learning. Instruments used include daily logs, behavior checklists, and observation diaries. Manual observation allows direct monitoring of child development, social interactions, and responses to learning programs. However, it is prone to subjective bias, low inter-observer consistency, and is difficult to digitize (Aurilia et al., 2025; Suhardi, 2025).

Interviews

Interviews are used to obtain in-depth information about the experiences, perceptions, and views of teachers, parents, or children (with appropriate approaches). Techniques include face-to-face interviews, semi-structured interviews, and focus group discussions. Interviews enable the collection of rich qualitative data but require skilled interviewers and are relatively time-consuming. Technology can be integrated through online interviews with audio or video recording, facilitating documentation and analysis (Evans et al., 2025; Noviandy & Maulana, 2025).

Questionnaires

Questionnaires are a widely used method for collecting quantitative data from a large number of respondents in early childhood education management. They can be administered as written forms or digital surveys with structured questions designed to measure opinions, satisfaction, and perceptions of teachers, parents, or administrative staff. The integration of technology through online survey platforms enables faster data collection, automated processing, and more efficient management of databases. Despite these advantages, questionnaires have notable limitations, including the risk of respondents providing dishonest answers and the inability to capture deep, qualitative insights. Proper design and validation are essential to ensure reliability and meaningful results (Boateng et al., 2024; Bulut et al., 2024).

Learning Analytics

Learning analytics represents a technological advancement that leverages digital data to monitor, evaluate, and predict both child behavior and teacher performance in early childhood education settings. Data are collected from learning management systems (LMS), interactive educational applications, and various other digital devices used in the learning environment. This approach facilitates rapid data analysis, enabling personalized interventions tailored to individual children and supporting evidence-based decision-making by educators and administrators. Despite its potential benefits, implementing learning analytics faces significant challenges, including the requirement for robust technological infrastructure, the need to enhance teacher competencies in data interpretation, and critical concerns regarding data privacy and security (Ilyas et al., 2025; Molla-Esparza et al., 2025)

Big Data

The application of big data in early childhood education management encompasses the collection of extensive datasets from diverse sources, including academic records, digital learning interactions, program evaluations, and children's environmental information. This approach enables the identification of trends and patterns that are often undetectable through traditional data collection methods. By analyzing these large datasets, educators and administrators can predict educational outcomes, assess program effectiveness, and make evidence-based decisions to enhance learning experiences. Despite its potential, big data utilization presents challenges such as complex analytical requirements, significant demands for technological resources, and potential risks to data privacy, necessitating robust security measures and ethical oversight (Ilyas et al., 2025; Sunarto et al., 2024).

Table 1. Evolution of Data Collection Techniques in Early Childhood Education Management

Data Collection Technique	Method	Instrument/ Tool	Technology Integration	Key Findings	Gaps/ Challenges
Manual Observation	Qualitative	Daily logs, checklists	Minimal/ Traditional	Facilitates direct monitoring of child development	Subjective bias, low consistency, difficult to digitize
Interviews	Qualitative	Face-to-face, semi-structured, focus groups	Moderate	Explores perceptions of teachers, parents, and children	Requires skilled interviewers, time-consuming, subjective risk
Questionnaires	Quantitative	Written/Digital forms	High	Effective in measuring opinions, satisfaction, perceptions	Limited responses, data quality depends on honesty
Learning Analytics	Quantitative /Qualitative	LMS, digital learning apps	High	Behavior analysis, personalized intervention	Requires infrastructure, teacher competency, data privacy
Big Data	Quantitative	Integrated databases, digital logs, sensors	Very High	Trend identification, predictive educational outcomes	High complexity, privacy risks, technology resources

Source processed by researcher

Table 1 illustrates the transition of data collection techniques in early childhood education management from traditional manual methods to digital and data-analytic approaches, highlighting their respective benefits and challenges. Manual observation allows

direct monitoring of children's behavior and social interactions but is prone to bias, low consistency, and limited digital integration. Interviews provide in-depth qualitative insights yet require skilled interviewers and are time-consuming. Questionnaires facilitate large-scale quantitative data collection, although they may lack depth and depend on respondent honesty. Learning analytics enables personalized interventions and rapid analysis, while big data integrates multiple sources to reveal trends and predict outcomes, albeit requiring advanced infrastructure, technical expertise, and data privacy safeguards.

Trends in the Evolution of Data Collection Techniques

The literature indicates a clear trend from traditional methods to digital approaches with analytics integration. Manual observation remains foundational for directly assessing child behavior. Digital questionnaires and online interviews enable faster, structured data collection. Meanwhile, learning analytics and big data have brought a significant transformation, allowing automated analysis, child development prediction, and personalized interventions (Ersozlu et al., 2024; Fernández-Sánchez et al., 2025; Tri et al., 2025).

Technology integration not only accelerates the process but also enhances data accuracy and validity. However, it demands digital infrastructure, data analysis skills, and attention to ethical and privacy issues. The gap between technological potential and actual practice in PAUD highlights the need for teacher training, data protection policies, and the development of adaptive, user-friendly instruments (Evans et al., 2025; Huong et al., 2024).

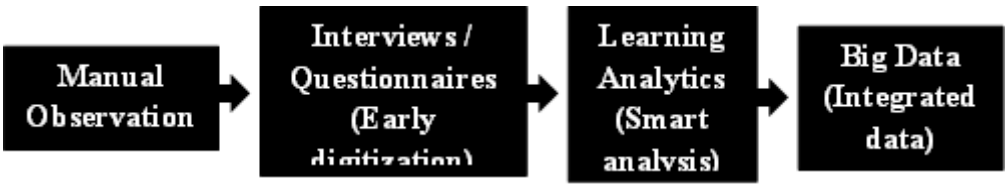

Figure 1. Diagram of Data Collection Technique Evolution in Early Childhood Education

Figure 1 illustrates the evolutionary flow of data collection techniques in early childhood education, showing the transition from traditional manual methods to advanced technological integration and big data analytics. The process begins with manual observation, which allows direct monitoring of children's behavior and interactions but is limited by subjectivity and low consistency. It progresses to interviews and questionnaires, providing structured qualitative and quantitative insights. The introduction of digital tools enhances efficiency, data accuracy, and storage capabilities. Learning analytics further enables real-time monitoring and personalized interventions, while big data integrates multiple data sources to identify patterns, predict outcomes, and evaluate program effectiveness. This flow highlights the increasing sophistication, accuracy, and potential of technology-driven data collection in early childhood education.

Gaps and Challenges

The literature identifies several gaps in early childhood education data collection practices. First, despite available advanced technology, many institutions have not adopted it

due to limited resources and teacher competency. Second, data collection techniques are still largely quantitative-focused, with in-depth qualitative data often neglected. Third, privacy and data security are major challenges in implementing learning analytics and big data. Finally, methodological gaps emerge because some studies fail to report data collection procedures systematically, hindering replication and validation (Bulut et al., 2024; Hamid, 2025; Khalil et al., 2025).

Technology-Based Solutions

Technology can be strategically leveraged to enhance data collection in early childhood education institutions. Integrating learning analytics with learning management systems (LMS) enables real-time monitoring of children's development, allowing educators to implement timely and precise interventions. The use of big data supports longitudinal analysis, predicts developmental outcomes, and facilitates comprehensive evaluation of educational programs. Mobile applications and digital platforms for conducting interviews and administering questionnaires accelerate data gathering while enabling automated analysis and reporting. Effective utilization of these technologies requires teacher training in data literacy and analytics to ensure informed decision-making. Additionally, adapting digital instruments to the early childhood education context is essential for accurate and meaningful data capture. Robust data protection policies and clear ethical guidelines must be enforced to safeguard the privacy of both children and educators (Latif & Zhai, 2025; Logan et al., 2025).

Table 2. Technology Integration and Challenges in Early Childhood Education Data Collection Techniques

Technique	Technology Integration Level	Benefits	Challenges	Potential Solutions
Manual Observation	Low	Direct monitoring of child behavior	Observer bias, hard to automate	Digitization of logs, observer training
Interviews	Moderate	In-depth information	Subjectivity, time-consuming	Online interviews, audio/video recording, digital analysis
Questionnaires	High	Fast, large-scale survey	Limited responses, variable quality	Online survey platforms with validation
Learning Analytics	Very High	Real-time analysis, personalization	Infrastructure, data privacy	Teacher training, data policies, LMS integration
Big Data	Maximum	Prediction, pattern identification, program evaluation	Complexity, privacy risk, resources	Cloud computing, data security standards, analytics

dashboards

Source processed by researcher

Table 2 emphasizes the importance of tailoring data collection strategies in early childhood education institutions according to the level of technology integration, associated benefits, potential challenges, and appropriate solutions. Low-tech methods, such as manual observation, enable direct monitoring of children's behavior but face limitations like observer bias and difficulty in automation. Moderate-tech approaches, including interviews and early digital tools, provide richer qualitative insights yet require skilled interviewers and additional time. High-tech strategies, such as digital questionnaires, learning analytics, and big data, enhance efficiency, enable real-time analysis, support predictive insights, and facilitate evidence-based decisions. Effective implementation requires teacher training, infrastructure support, adaptive instruments, and robust data privacy measures to maximize the benefits of technology while addressing its challenges.

Synthesis of Findings

Based on the literature, the evolution of early childhood education data collection can be synthesized as follows. Initial data collection emphasized manual observation and daily logs, focusing on descriptive child behavior. Subsequently, interviews and questionnaires were introduced to gather qualitative and quantitative information from teachers and parents. Technological advancements significantly improved learning analytics, utilizing digital data for behavior analysis, predictive assessment, and evaluation of learning interventions. Big data further extends analysis by integrating multiple data sources, enabling longitudinal and predictive evaluation (Maesaroh, 2025; Maulana et al., 2023; Pulungan et al., 2025).

This trend demonstrates that technology integration enhances accuracy, efficiency, and personalization in data collection. Yet, gaps remain due to limited teacher competency, institutional resources, and suboptimal data protection procedures. Quantitative methods dominate, whereas in-depth qualitative exploration, particularly regarding children's social and emotional contexts, remains insufficient.

Practical Implications

The study's findings have significant practical implications. First, early childhood education institutions should adopt a balanced combination of qualitative and quantitative methods to obtain a comprehensive understanding of child development. Second, technology integration such as learning analytics and big data must match institutional infrastructure and teacher competencies. Third, development of adaptive, user-friendly digital instruments will accelerate data collection and facilitate analysis. Fourth, data protection policies and ethical standards should be applied to ensure child data security. Fifth, teacher training in data literacy is crucial to optimize technology use (Damayanti et al., 2025; Suhardi, 2025).

Table 3. Recommendations for Early Childhood Education Data Collection Practices

Recommendation	Description	Benefits

Method Combination	Combine observation, interviews, questionnaires, and digital analytics	More complete data, improved analysis quality
Teacher Training	Data literacy and use of technology for data collection	Enhances analytical ability, reduces bias
Technology Integration	LMS, mobile apps, big data, learning analytics	Efficient data collection, real-time monitoring, outcome prediction
Adaptive Instruments	Flexible questionnaires and observation sheets	Responsive to children's needs, easy to use
Privacy Policy	Child data security and ethics standards	Protects privacy, builds stakeholder trust

Source processed by researcher

Table 3 presents practical recommendations to enhance data-driven management in early childhood education institutions. The literature review indicates that data collection techniques in early childhood education management have evolved significantly, shifting from traditional manual methods toward advanced technology integration and data analytics. Manual observation and interviews remain essential for capturing qualitative insights into children's behavior, interactions, and learning processes. Meanwhile, digital questionnaires, learning analytics, and big data offer faster, more accurate, and predictive capabilities, enabling institutions to monitor development, assess program effectiveness, and implement personalized interventions.

The integration of technology provides substantial benefits, including efficiency in data collection, real-time monitoring, personalized educational strategies, and evidence-based decision-making. However, it also introduces challenges related to teacher competencies, availability of technological resources, infrastructure limitations, and data privacy concerns. Many PAUD institutions still face low adoption rates of technology, an overreliance on quantitative methods, and insufficient exploration of qualitative aspects such as socio-emotional development and contextual learning.

To address these gaps, this study recommends combining multiple data collection methods, providing targeted teacher training, developing adaptive and user-friendly instruments, integrating technology systematically, and enforcing robust data privacy policies. By implementing these strategies, early childhood education institutions can improve the accuracy, relevance, and utility of collected data. Overall, these findings provide a comprehensive understanding of the evolution of data collection in early childhood education, forming a foundation for evidence-based management, innovation, and the effective use of technology in early childhood education.

DISCUSSION

This discussion indicates that data collection techniques in Early Childhood Education management have undergone a significant transformation from traditional approaches toward the use of digital technology and advanced analytics. Literature findings show that traditional methods such as manual observation, interviews, and questionnaires still dominate early

childhood education practices, particularly in institutions with limited resources and infrastructure (Aurilia et al., 2025; Maesaroh, 2025). While these methods provide rich contextual data, dependence on interviewer skills and human bias remains a major limitation, affecting data consistency and accuracy.

Within the evolution framework, modern techniques such as learning analytics (LA), big data, and artificial intelligence (AI) integration have emerged as powerful tools for providing real-time data, enabling monitoring of child development, and supporting evidence-based decision-making (Ersozlu et al., 2024; Maulana et al., 2023; Noviandy et al., 2025). Noviandy & Maulana (2025) emphasize that LA and educational data mining offer predictive and personalized capabilities relevant to early childhood education management development. These findings are reinforced by Damayanti et al. (2025), who highlight digital transformation in elementary school management through technology integration.

Literature on human-centred learning analytics underscores the importance of designing systems that involve stakeholders, including educators and children, to enhance trust, relevance, and data accuracy (Alfredo et al., 2023). This suggests that technology adoption is not merely automation but requires active user engagement, particularly in early childhood education contexts sensitive to children's developmental needs. Fernández-Sánchez et al. (2025) also support this perspective, emphasizing AI integration in developing analytics-based educational assessment rubrics that require participatory design.

Critiques and controversies regarding modern technology adoption are also documented. Bulut et al. (2024) highlight ethical opportunities and challenges related to AI in educational measurement, while Khalil et al. (2025) and Latif & Zhai (2025) stress the need for data privacy and security mechanisms prior to broad implementation. Bulut et al. (2024) and Suhardi (2025) assert that infrastructure limitations, teacher competencies, and privacy issues are key barriers to AI and big data application in education, consistent with this study's findings. Logan et al. (2025) also show that researcher trust and readiness are crucial factors in data sharing, relevant to LA implementation in early childhood education.

Some studies support the continued dominance of traditional methods. Qualitative research indicates that observation, interviews, and documentation remain primary techniques for understanding management practices and child development (Aurilia et al., 2025; Maesaroh, 2025). However, broader educational evaluation literature emphasizes that triangulation combining observation, interviews, and documentation can enhance data validity and reliability (Hamid, 2025; Kasih & Muspawi, 2024). This confirms that transitioning to modern techniques still requires a foundation in traditional methods to maintain contextual and meaningful data.

Conversely, literature addressing advanced technique challenges reminds that LA and AI are not universally suitable and may involve high investment costs without adequate contextual support (Sapkota, 2024; Siddiqua, 2023). Zhao et al. (2024) emphasize that databases and big data as methods require pedagogical contextual attention to avoid misinterpretation. Therefore, a balance exists between optimism about technology and the need for proper contextualization, especially in early childhood education settings.

Implications for early childhood education practice indicate that enhancing data-driven educational management requires developing human resource capacity and digital

infrastructure while retaining the strengths of traditional methods. LA and AI enable real-time child development monitoring, support tailored pedagogical interventions, and strengthen overall management evaluation (Noviandy & Maulana, 2025; Pulungan et al., 2025; Sunarto et al., 2024).

This study contributes by providing an overview of methodological and technological evolution in early childhood education data collection, integrating findings from literature on learning analytics, big data, and AI to show general trends and implementation challenges. It offers a theoretical basis for further research and evidence-based management practice while highlighting the balance between traditional and modern methods (Boateng et al., 2024; Ilyas et al., 2025; Yenisa & Putri, 2024).

Study limitations include reliance on secondary literature and a lack of direct empirical data from early childhood education. Most advanced technology studies were analyzed in elementary or higher education contexts, so generalization to early childhood education requires caution (Bahrani et al., 2025; Evans et al., 2025; Huong et al., 2024).

Future research should focus on empirical studies evaluating modern data collection techniques in early childhood education, including experimental case studies comparing traditional versus advanced methods. Research should also explore teacher training strategies in data and analytics usage and develop ethical guidelines for child data privacy and security in digital learning environments (Bulut et al., 2024; Khalil et al., 2025; Latif & Zhai, 2025).

CONCLUSION

In conclusion, the evolution of data collection in early childhood education management reflects a gradual shift from traditional observation, interviews, and questionnaires toward the integration of learning analytics, big data, and AI, providing real-time, predictive, and personalized insights. While modern technologies enhance evidence-based decision-making and program evaluation, challenges remain in infrastructure, teacher competencies, ethical considerations, and contextual applicability. Effective practice requires a balanced approach that combines traditional methods with advanced tools, supported by stakeholder engagement, capacity building, and robust data privacy measures. Addressing these gaps can strengthen data-driven management, optimize child development monitoring, and guide future empirical research in early childhood education contexts.

BIBLIOGRAPHY

Alfredo, R., Echeverria, V., Jin, Y., Yan, L., Swiecki, Z., Gašević, D., & Martinez-Maldonado, R. (2023). Human-Centred Learning Analytics and AI in Education: A Systematic Literature Review. *arXiv*. https://doi.org/10.48550/arXiv.2312.12751

Aurilia, D., Putra, Z. H., & Corpiady, J. (2025). Strategi Pengumpulan Data Kualitatif dalam Penelitian Implementasi Kebijakan Pendidikan (SLR). *Didaktik: Jurnal Ilmiah PGSD STKIP Subang*, *11*(02), 244–254. https://doi.org/10.36989/didaktik.v11i02.6903

Bahrani, Ananiah, Rohim, M., & Muhsin, M. (2025). Strengthening school management to improve educational quality. *School Management Journal*, *8*(3), 509–523. https://doi.org/DOI:%2520https://doi.org/10.37758/jat.88i3.85

Boateng, S. L., Obed Kwame Adzaku Penu, Boateng, R., Budu, J., Marfo, J. S., & Asamoah, P. (2024). Educational technologies and elementary level education – A bibliometric review. *Heliyon*, *10*(7). https://doi.org/10.1016/j.heliyon.2024.e28101

Bulut, O., Beiting-Parrish, M., Casabianca, J. M., Slater, S. C., Jiao, H., Song, D., Ormerod, C., Fabiyi, D. G., Ivan, R., Walsh, C., Rios, O., Wilson, J., Yildirim-Erbasl, S. N., Wongvorachan, T., Joyce Xinle Liu, Tan, B., & Morilova, P. (2024). The Rise of Artificial Intelligence in Educational Measurement: Opportunities and Ethical Challenges. *arXiv*. https://doi.org/10.48550/arXiv.2406.18900

Damayanti, D. F., Wuryandini, E., & Ginting, R. B. (2025). Smart School Management Through Digital Transformation: A Case Study of Nasima Elementary School, Semarang City. *IJORER : International Journal of Recent Educational Research*, *6*(5), 1468–1481. https://doi.org/10.46245/ijorer.v6i5.965

Ersozlu, Z., Taheri, S., & Koch, I. (2024). A review of machine learning methods used for educational data. *Education and Information Technologies*, *29*(16), 22125–22145. https://doi.org/10.1007/s10639-024-12704-0

Evans, B. J., Bettinger, E. P., & Antonio, A. L. (2025). Data Collection and Monitoring in an Educational RCT of a Postsecondary Access Program: Assessing Internal and External Validity. *Education Sciences*, *15*(3), 363. https://doi.org/10.3390/educsci15030363

Fernández-Sánchez, A., Lorenzo-Castiñeiras, J. J., & Sánchez-Bello, A. (2025). Navigating the Future of Pedagogy: The Integration of AI Tools in Developing Educational Assessment Rubrics. *European Journal of Education*, *60*(1), e12826. https://doi.org/10.1111/ejed.12826

Hamid, S. (2025). A Critical Review of Educational Research Methodologies: Approaches, Applications, and Implications. *Pakistan Social Sciences Review*, *9*(2), 138–150. https://doi.org/DOI:10.35484/pssr.2025(9-II)11

Huong, V. T. M., Hue, H. T. K., Chau, D. T. M., Nguyet, N. T. M., Quy, T. T., & Tri, N. Q. (2024). A dataset on analysis of school-based management research from 1984 TO 2023. *Data in Brief*, *56*, 110823. https://doi.org/10.1016/j.dib.2024.110823

Ilyas, Wahab, Imran, Mahluddin, & Asmawati. (2025). Digital Transformation in Educational Management. *Scaffolding Journal*, *7*(3), 78–90. https://doi.org/10.37680/scaffolding.v7i3.7735

Kasih, A. C., & Muspawi, M. (2024). Literature Study: Development Of Research Instruments For Educational Management Performance Evaluation. *J-CEKI : Jurnal Cendekia Ilmiah*, *4*(1), 1888–1892. https://doi.org/10.56799/jceki.v4i1.5837

Khalil, A., Shakya, R., & Liu, Q. (2025). Towards Privacy-Preserving Data-Driven Education. *arXiv*. https://doi.org/10.48550/arXiv.2503.13550

Latif, M., & Zhai, Y. (2025). Privacy-Preserved Automated Scoring using Federated Learning. *arXiv*. https://doi.org/10.48550/arXiv.2503.11711

Logan, J. A. R., Hayward, A. L., Swanz, L. E., & Ceviren, A. B. (2025). Education Researchers' Beliefs and Barriers Towards Data Sharing. *Quality & Quantity*, *59*, 4061–4075. https://doi.org/10.1007/s11135-025-02188-6

Maesaroh, I. (2025). Teknik Pengumpulan Data. *Pendas: Jurnal Ilmiah Pendidikan Dasar*, *10*(2). https://doi.org/DOI:%2520https://doi.org/10.23969/jp.v10i02.27110

Maulana, A., Idroes, G. M., & Kemala, P. (2023). Leveraging AI to Predict Student Performance: A Comparative Machine Learning Approach. *Journal of Educational Management and Learning*, *1*(2), 64–70. https://doi.org/10.1111/ejed.70359

Molla-Esparza, C., Gómez-Núñez, M. I., & García-García, F. J. (2025). Applications of learning analytics in the study of academic performance in higher education: A pilot-tested meta-review protocol. *International Journal of Educational Research Open*, *8*, 100433. https://doi.org/10.1016/j.ijedro.2024.100433

Noviandy, T. R., Idroes, G. M., Paristiowati, M., & Idroes, R. (2025). Techniques and Tools in Learning Analytics and Educational Data Mining: A Review. *Journal of Educational Management and Learning*, *3*(1), 44–52. https://doi.org/10.60084/jeml.v3i1.308

Noviandy, T. R., & Maulana, A. (2025). Application of Learning Analytics to Improve Educational Management Research. *Journal of Educational Management and Learning*, *4*(1). https://heca-analitika.com/jeml/article/view/312

Pulungan, R., Br.Ginting, L. S. D., & Putri, E. (2025). AI Integration in Learning: Case Study of Indonesian Language and Literature Education Students at a Private University in Indonesia. *AL-ISHLAH: Jurnal Pendidikan*, *17*(3), 4303–4314. https://doi.org/10.35445/alishlah.v17i3.5585

Sapkota, M. (2024). Implications and Critiques of Quantitative Research. *LTM Journal*, *5*(3), 153–159. https://doi.org/10.17309/jltm.2024.5.3.09

Siddiqua, A. (2023). Critique of Research Methodologies and Methods in Educational Leadership. *World Journal of Education*, *13*(4). https://files.eric.ed.gov/fulltext/EJ1409750.pdf

Suhardi, M. (2025). Optimizing educational management with artificial intelligence in Indonesian higher education: A qualitative exploration. *Journal of Educational Management and Instruction (JEMIN)*, *5*(2), 265–280. https://doi.org/10.22515/jemin.v5i2.11046

Sunarto, S. A., Maulidina, C. P., & Wijaya, W. V. (2024). Kajian Literatur: Penerapan Big Data dan Artificial Intelligence untuk Perkembangan Bidang Edukasi dan Bisnis. *Kinesik*, *11*(3), 300–312. https://doi.org/10.22487/ejk.v11i3.1366

Tri, N. Q., Huong, V. T. M., Hue, H. T. K., Chau, D. T. M., Nguyet, N. T. M., & Quy, T. T. (2025). Exploring Research on School-Based Management in the Scopus Database (1984–2023): A Bibliometric Analysis. *European Journal of Education*, *60*(4), e70359. https://doi.org/10.1111/ejed.70359

Yenisa, N., & Putri, N. A. (2024). Literature Review: Technology-Based Educational Management in Learning. *International Journal of Educational Evaluation and Policy Analysis*, *1*(3), 50–84. https://doi.org/10.62951/ijeepa.v1i3.358

Zhao, X., Ng, R., Zomer, C., Duffy, G., & Sefton-Green, J. (2024). Database as Method: Exposing 'Data' About Educational Technology. *Computers & Education Open*, *6*. https://doi.org/10.1016/j.caeo.2024.100188