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Transformational Leadership in Managing AI-Based Early Childhood Education: A Study in South Sulawesi

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ABSTRACT. This study aims to analyze the role of transformational leadership in the management of artificial intelligence (AI)-based early childhood education in South Sulawesi. This study used a mixed methods approach and involved 15 administrators and 150 instructors from 30 regional schools. Quantitative data were collected through a questionnaire survey and analyzed using linear regression, while qualitative data were obtained through in-depth interviews and document analysis. The study findings revealed that transformational leadership significantly influenced the success of AI-based education management, with a regression coefficient (β) of 0.75 ($p < 0.01$). Key factors such as strategic vision, effective communication, teacher capacity development, and organizational support play an important role. However, challenges such as limited infrastructure, inadequate technical training, and inadequate education policies remain. This study contributes to educational management science by demonstrating how transformational leadership can be a strategic driver to overcome implementation barriers and improve technology integration in early childhood education. Practical implications include guiding school leaders in leadership development programs, informing policy formulation to support AI-based learning, and enhancing institutional readiness for educational innovation. Academically, this research enriches the discourse on applying leadership theory in the context of technological transformation in education.

Keywords: *AI-based education, early childhood education, technology implementation, transformational leadership*

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INTRODUCTION

Artificial Intelligence (AI)-based education has emerged as a global trend transforming the educational landscape in the 21st century (Ree & Wiig, 2020). This technology offers numerous opportunities to enhance educational quality, including personalized learning, real-time student data analysis, and the development of more adaptive learning materials (Park et al., 2022). In many developed countries, implementing AI in education has successfully created more innovative and efficient learning ecosystems (Wamba-Taguimdje et al., 2020). However, in developing countries like Indonesia, adopting such technologies faces significant challenges, including limited infrastructure, digital inequality, and educators' lack of technical capacity (Cao & Le, 2024).

South Sulawesi, a province with substantial educational potential, has begun to respond to this trend by integrating AI technology into early childhood education (Broome, 2024). Some schools have attempted to adopt AI to enhance teaching effectiveness, but its implementation remains uneven (Labrague et al., 2020). Previous research indicates that leadership is pivotal in successfully transforming technology-based education (Wu et al., 2020). Transformational leadership, characterized by a clear vision, inspiration, and the ability to empower teachers, is considered instrumental in driving the adoption of new technologies in education (Yin et al., 2020).

AI-based early childhood education requires leaders who can create a strategic vision and inspire teachers to incorporate these technologies into the learning process (Begum et al., 2022). Transformational leaders act as decision-makers and agents of change who can overcome resistance to innovation and facilitate collaboration among various stakeholders (Madi Odeh et al., 2023). In South Sulawesi Province, where many schools face infrastructural limitations and a lack of technical training, the presence of transformational leaders becomes even more critical (Storey & Cunningham, 2024).

Despite extensive studies on the importance of transformational leadership across various contexts, research examining its role in implementing AI-based early childhood education in Indonesia remains limited (Curado & Santos, 2022). Most literature focuses on developed countries or the general adoption of technology without delving into the leadership dynamics within local contexts (Khan & Khan, 2022). Furthermore, there is a lack of comprehensive research combining quantitative and qualitative analyses to explore the success factors and challenges of implementing AI-based education in South Sulawesi (Dwivedi et al., 2020).

This study addresses this gap by exploring how transformational leadership can support AI-based early childhood education management in South Sulawesi. This study offers a comprehensive understanding of leadership dynamics and the application of AI technology in educational settings through a mixed-methods methodology. Its novelty lies in its contextual focus in South Sulawesi, the integration of methodological approaches, and an in-depth analysis of the relationship between leadership vision and the success of AI-based education implementation. Furthermore, this study contributes to educational management science by offering empirical insights to guide leadership strategies and policy formulation in managing educational innovation and technology integration.

METHOD

This study employed a mixed-methods design, combining quantitative and qualitative approaches to gain a comprehensive understanding of the role of transformational leadership in implementing Artificial Intelligence (AI)-based early childhood education in South Sulawesi. The research process comprised the following stages (Sugiyono, 2018).

Research Planning and Design

The study began by identifying research problems and objectives. A mixed-methods research design was then developed, incorporating a quantitative approach to measuring variable impacts and a qualitative approach to exploring contextual factors and participants' experiences. Research instruments, such as questionnaires for the quantitative survey and interview guides for the qualitative phase, were designed based on theoretical frameworks of transformational leadership and technology implementation in education.

Sampling

Based on basic education data from the Directorate General of Early Childhood Education, Basic Education and Secondary Education, Ministry of Basic and Secondary Education in 2025 (https://dapo.dikdasmen.go.id/sp/1/190000), it is known that the number of early childhood education teachers in South Sulawesi Province is 15,017, they are spread across 6,370 schools from

24 districts and cities. In this study, the sampling technique used the probability sampling technique, namely area sampling, which determines samples from several early childhood education schools in various districts in South Sulawesi. Furthermore, after schools from several districts are determined, the simple random sampling technique is used to select respondents randomly. The research sample included 150 teachers and 15 principals selected through purposive sampling. Respondents were taken from 30 schools that have begun integrating AI technology into their learning process in South Sulawesi. This sampling approach ensures the data's relevance to the study's focus.

Quantitative Data Collection

This phase involved distributing questionnaires to 150 teachers to assess their perceptions of transformational leadership and the extent to which AI-based early childhood education is being implemented in their schools. The questionnaire used a 5-point Likert scale to measure leadership vision, communication, teacher capacity building, and organizational support.

Qualitative Data Collection

Qualitative data were gathered through in-depth interviews with 15 school principals to understand their roles in supporting the implementation of AI-based early childhood education. Additionally, document analysis was conducted on school policies, teacher training reports, and technology development plans. The interviews were recorded, transcribed, and analyzed to identify key themes.

Quantitative Data Analysis

Quantitative data were analyzed using linear regression to examine the relationship between transformational leadership and AI-based early childhood education implementation. Statistical software was utilized to ensure the validity and reliability of the data.

Qualitative Data Analysis

Qualitative data were analyzed through thematic and content analysis. This process involved coding interview transcripts and documents to identify patterns, relationships between themes, and in-depth insights into the supporting factors and challenges in implementing AI-based early childhood education.

Data Triangulation

Data triangulation was carried out by contrasting the quantitative and qualitative data results to increase the validity of the conclusions. This made sure that the ideas from both methods were integrated and consistent.

Interpretation and Report Preparation

The results from quantitative and qualitative analyses were interpreted holistically to address the research objectives. The findings were compiled into a research report, which included practical implications and recommendations for developing transformational leadership to support AI-based early childhood education in South Sulawesi.

RESULT AND DISCUSSION

Result

This study produced significant findings regarding the role of transformational leadership in implementing Artificial Intelligence (AI)-based early childhood education in South Sulawesi. The results are summarized based on quantitative and qualitative approaches as follows.

Quantitative Analysis Results

From the survey data of 150 teachers, transformational leadership was found to influence the implementation of AI-based education significantly. The linear regression analysis revealed that: (1) the regression coefficient (β) was 0.75 with a p-value < 0.01, indicating a strong and significant relationship between transformational leadership and the level of AI-based education implementation; (2) the subdimension of leadership vision contributed the most, with a coefficient (β) of 0.82, followed by communication (β = 0.68), teacher capacity building (β = 0.65), and organizational support (β = 0.62).

Further analysis reveals that each subdimension of transformational leadership contributes differently to the implementation of AI-based education.

Table 1. Linear Regression Analysis Results

Transformational Leadership Subdimension	Coefficient (β)	Interpretation
Leadership Vision	0.82	The most influential factor in AI-based education implementation
Communication	0.68	Plays a crucial role in conveying the AI vision to all stakeholders
Teacher Capacity Development	0.65	Affects the improvement of teachers' competencies in AI
Organizational Support	0.62	Supports the successful implementation of AI in education

Based on Table 1 above, it is known that each subdimension of transformational leadership provides a different contribution to the implementation of AI-based education in early childhood in South Sulawesi. The Leadership Vision subdimension has the most dominant influence (β = 0.82), indicating that a strong and focused leadership vision is the main foundation for digital transformation in educational institutions. The Communication subdimension (β = 0.68) plays an important role in conveying the AI vision and strategy to all stakeholders, while Teacher Capacity Development (β = 0.65) reflects the importance of improving teacher competence in the effective use of technology and AI. Meanwhile, Organizational Support (β = 0.62) shows that structural and institutional support is essential to creating an educational ecosystem that supports AI adoption. These findings suggest that leaders with strategic vision, effective communication skills, and the ability to empower teachers play a critical role in facilitating the use of AI technology in schools.

Qualitative Analysis Results

Analysis of interviews with 15 principals and supporting documents revealed several key themes related to the implementation of artificial intelligence (AI) technology in schools. Principals with a clear strategic vision for AI integration can inspire teachers to adopt the technology despite infrastructure limitations. Among the 15 principals, four principals are analyzed for disclosure here. One principal stated (P1), *"Kami memang belum punya perangkat lengkap, tapi ketika visi itu disampaikan secara konsisten, guru-guru mulai tertarik mencoba meskipun dengan alat seadanya* [We do not have complete equipment yet, but when the vision is conveyed consistently, teachers start to be interested in trying it even with the tools available]." Increasing teacher capacity through intensive training and mentoring has proven to be important in building their confidence and skills in using AI technology. One principal stated (P2), *"Pelatihan rutin dan mentoring personal membuat guru-guru kami lebih percaya diri menggunakan platform AI dalam pembelajaran* [Regular training and personal mentoring make our teachers more confident using AI platforms in their learning]." In addition, effective communication from principals about the benefits and goals of implementing AI reduces teacher resistance to change. One principal explained (P3), *"Kami selalu terbuka berdiskusi soal AI ini di forum guru, sehingga tidak ada lagi rasa takut atau penolakan* [We are always open to discussing AI in teacher forums, so there is no more fear or rejection]." In order to ensure the sustainability of this program, organizational assistance—such as setting aside money for the purchase of technology, offering

training, and creating a support staff—is also crucial. One principal said (P4), *"Kami menyisihkan dana BOS untuk membeli perangkat dan membentuk tim kecil yang membantu guru jika mengalami kendala* [We set aside BOS funds to buy devices and form a small team to help teachers if they encounter obstacles]." According to this research, the success of implementing AI is significantly influenced by the alignment of vision, communication, training, and organizational support.

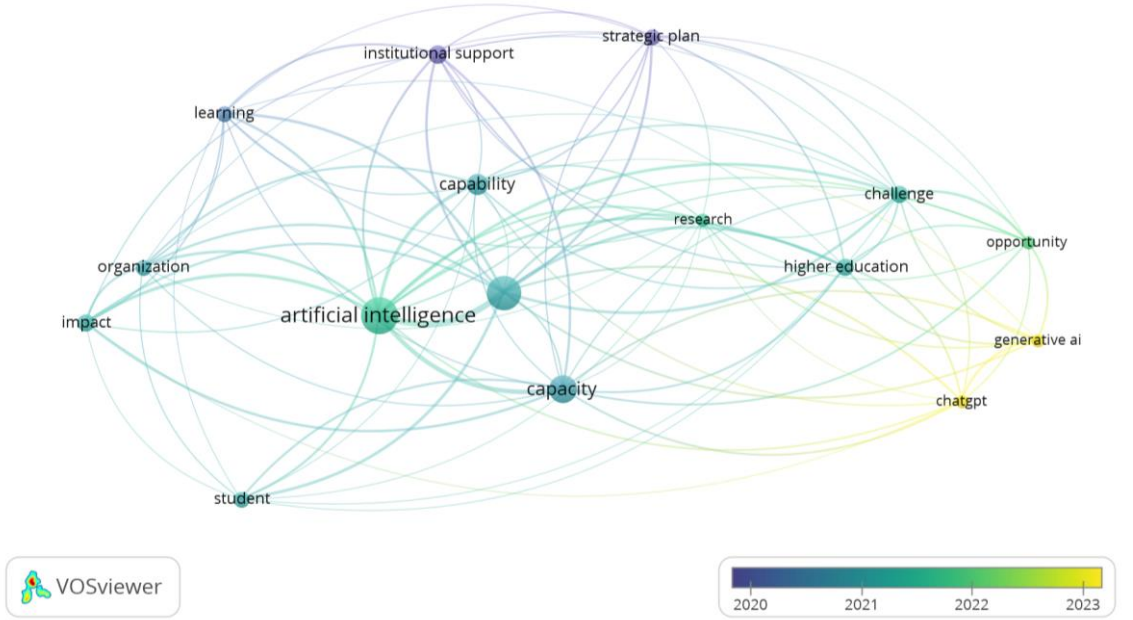

Figure 1. Bibliometric Visualization of Artificial Intelligence Trends and Keyword Co-occurrence in Early Childhood Education Research (2020–2023)

Figure 1 above explains the co-occurrence-based bibliometric visualization of keywords analyzed using VOSviewer, showing conceptual relationships and temporal trends in research related to artificial intelligence (AI) in higher education. The size and thickness of the lines indicate the strength of the relationship between terms, while the color gradient from blue to yellow indicates the temporal development from 2020 to 2023. Keywords such as artificial intelligence, capacity, capability, and higher education are the central nodes connected to terms such as student, impact, learning, and most recently, generative AI and ChatGPT, reflecting the shift in research focus to generative AI technology in modern learning. This finding emphasizes the importance of visionary leadership adapting to technological developments. Transformational leaders in AI-based early childhood education need to understand the dynamics of change shown in this map—especially the ability to integrate cutting-edge technologies such as ChatGPT into the learning process tailored to the capacity and needs of early childhood learners. Moreover, transformational leaders must be able to develop institutional capacity, provide strategic support, and manage the ethical and pedagogical challenges that arise from early AI use, as reflected in the close relationship between capability, institutional support, and strategic plan in this visualization.

Despite positive efforts to integrate artificial intelligence (AI) technology in schools, several major challenges remain obstacles to its implementation. One of the most significant challenges is limited infrastructure, especially in schools in remote areas that do not yet have adequate internet access to support optimal use of AI technology. In addition, there is still a policy gap, where education policies at the regional level have not fully accommodated the need to implement AI technology in terms of regulation and operational support. Another challenge is the low level of technological literacy among teachers, where some teachers have difficulty understanding and using AI-based devices due to the lack of comprehensive technical training. These three aspects indicate

the need for systemic intervention so that the adoption of AI technology in education can run evenly and sustainably.

Triangulation between Quantitative and Qualitative

Triangulation between quantitative and qualitative data shows consistent findings that transformational leadership contributes significantly to overcoming various challenges and supporting implementing AI-based early childhood education. Elements such as clear vision, effective communication, teacher capacity development, and organizational support are identified as key success factors. These findings produce several practical implications, including leadership training for school principals to improve their transformational skills, expanding access to technology infrastructure, especially in remote areas, and developing education policies that better support integrating AI technology into the curriculum. Overall, this study confirms that transformational leadership plays a central role in facilitating the implementation of AI-based education at the early childhood education level, although various structural and technical challenges still need to be overcome.

Discussion

AI-based education has become a major focus in the global transformation of education (Odugbesan et al., 2023). This technology not only enhances the efficiency of education management but also provides more personalized and adaptive learning experiences for students (Khan & Khan, 2022). However, adopting AI technology in education requires strong support from various stakeholders, including visionary and transformational education leaders (Meng, 2022). In the context of South Sulawesi, this study revealed how transformational leadership plays a crucial role in supporting the implementation of AI-based early childhood education and the challenges encountered in the process (Giergia, 2025; Mayangsari et al., 2024).

As described by Philip (2021), transformational leadership emphasizes inspiration, motivation, and the empowerment of organizational members to achieve greater goals. This study found that transformational leaders in South Sulawesi schools were able to create strategic visions that motivated teachers to adopt AI technology (Alwali & Alwali, 2022); (Aziziyah et al., 2024). These findings align with Hossain et al. (2025), who noted that transformational leadership fosters innovation by motivating individuals to exceed their expectations (Wang, 2021).

Specifically, in early childhood education settings, transformational leaders in South Sulawesi played a critical role in shaping a supportive environment for teachers and young learners. By inspiring early childhood educators to embrace AI-based tools, these leaders enhanced teaching effectiveness and nurtured foundational digital literacy skills in children (Abenoja et al., 2024). Another critical factor highlighted is the importance of effective communication in supporting the implementation of AI-based education (Ahmed & Al Amiri, 2022). Leaders who communicate the vision and benefits of AI technology to teachers can reduce resistance to change (Matsunaga, 2022). Effective communication also facilitates collaboration among teachers, students, and other stakeholders, ensuring smoother implementation of AI (Knezović & Drkić, 2021). Additionally, teacher capacity building emerged as a key factor in implementing AI-based education (Cantú-Ortiz et al., 2020). Teachers who received technical and pedagogical training on AI technology showed increased motivation and competence in integrating these tools into their teaching (Okunlaya et al., 2022). This is supported by findings from Suwanto et al. (2022), which demonstrated that continuous training enhances teachers' confidence in using digital technologies.

However, this study also identified several significant challenges in implementing AI-based education in South Sulawesi (Schiuma et al., 2022). Infrastructure limitations, such as uneven internet access, were a major obstacle for schools in remote areas (Jaiswal & Arun, 2021). Furthermore, a lack of education policies supporting AI integration at the regional level hindered progress (Islam et al., 2021). The government, schools, and communities need collaborative efforts

to address these challenges (Fullan et al., 2024). This study also underscores the need for more responsive education policies to technological advancements (Okwu et al., 2025). Proactive and adaptive policies, such as budget allocations for technology infrastructure and teacher training programs, can accelerate the implementation of AI-based education (Antonopoulou et al., 2021). Trim and Lee (2022) emphasized that proactive policies support technology-driven educational transformation (Fadhilah et al., 2024).

This study contributes significantly to the literature on transformational leadership and technology implementation in education. Focusing on the South Sulawesi context highlights the unique dynamics faced by schools in the region and provides strategic steps to optimize the potential of AI technology in early childhood education. By contextualizing the findings in early childhood education in South Sulawesi, this research provides a deeper understanding of how leadership characteristics directly affect the preparedness of young learners and their educators in adapting to AI-based learning environments.

CONCLUSION

This study shows that transformational leadership is crucial in supporting implementing artificial intelligence (AI)-based early childhood education in South Sulawesi. Leadership that emphasizes strategic vision, effective communication, teacher capacity development, and organizational support has been proven to overcome challenges such as limited infrastructure and lack of technical training. With a mixed-methods approach, this study provides a holistic understanding of how transformational leaders can act as change agents in driving technology-based educational innovation. Theoretically, these findings contribute to the development of transformational leadership theory by highlighting its relevance and adaptability in the unique context of early childhood education in developing regions. Practically, this study provides insights for education practitioners and policymakers regarding strategies for optimizing the role of leadership in facilitating AI-based learning environments. Furthermore, this study expands the discourse in educational management science by highlighting leadership strategies in the digital transformation era, especially at the early childhood education level. Based on these findings, it is recommended that leadership training programs be developed specifically for educators and heads of PAUD units, focusing on strengthening visionary leadership, technological literacy, and change management to ensure effective integration of AI technology.

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