DEVELOPMENT OF ARTIFICIAL INTELLIGENCE-BASED TQM TO IMPROVE TEACHER PERFORMANCE AND THE QUALITY OF LEARNING IN KINDERGARTENS

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Abstract

This article aims to examine the development of Artificial Intelligence (AI)-based Total Quality Management (TQM) to enhance teacher performance and learning quality in kindergarten education. This study employs a literature review approach by analyzing recent theoretical frameworks, empirical studies, and policy documents related to TQM in education, AI integration in educational management, and teacher performance improvement in early childhood education. The review indicates that integrating AI into TQM strengthens continuous quality improvement through data-driven decision-making, systematic performance evaluation, and structured feedback mechanisms. AI supports the PDCA cycle by enabling real-time monitoring, predictive analysis, and evidence-based managerial decisions. Conceptually, AI-based TQM offers an innovative quality management framework that enhances teacher professionalism and optimizes learning processes in kindergarten settings. This approach is relevant to digital transformation in education and provides a foundation for future empirical research in early childhood quality management systems.

Keywords: Total Quality Management; Artificial Intelligence; Kinerja Guru; Mutu Pembelajaran; Taman Kanak-Kanak

INTRODUCTION

Early childhood education (PAUD) is the most fundamental stage in the education system because it is during this phase that the foundations of children's cognitive, social-emotional, language, moral, and motor development are systematically established. Various developmental studies indicate that the quality of stimulation in early childhood has a significant correlation with learning readiness and academic success in subsequent educational levels. Therefore, the quality of learning in kindergarten (TK) has not only short-term impacts but also determines the quality of human resources in the long term.

The quality of learning at the kindergarten level is largely determined by the performance of teachers as the primary agents in designing meaningful play-based learning experiences. Kindergarten teachers are expected not only to manage the classroom but also to understand children's developmental characteristics, develop adaptive lesson plans, conduct authentic assessments, and engage in continuous reflection on their pedagogical practices. However, in practice, several structural and managerial issues persist, such as performance evaluation systems that are not data-driven, unsystematic monitoring of educational quality, and a lack of a reflective culture within school organizations. These conditions result in inconsistent educational service quality and suboptimal improvements in teacher professionalism.

From an educational management perspective, Total Quality Management (TQM) offers a strategic approach that emphasizes comprehensive quality improvement through the principles of continuous improvement, the involvement of all organizational components, visionary leadership, and data-driven decision-making. TQM does not merely focus on end results but emphasizes the systematic control and refinement of processes. In the context of early childhood education, the implementation of TQM should be able to foster a culture of

quality that prioritizes the quality of learning and encourages teachers to continuously innovate and engage in professional reflection.

Nevertheless, the implementation of TQM in early childhood education institutions still faces various limitations, particularly regarding data management and evaluation systems. Many educational institutions still rely on manual approaches for monitoring and evaluation, resulting in decision-making processes that tend to be subjective and lack empirical evidence. These challenges become increasingly complex in the era of digital transformation, which demands that educational institutions adapt to technological advancements and the needs of the digital generation.

Advances in Artificial Intelligence (AI) present opportunities for transformation in educational quality management. AI enables the rapid and accurate processing of large volumes of data, comprehensive analysis of performance patterns, and the provision of algorithm-based recommendations to support more objective decision-making. In the field of education, AI has been utilized for learning analytics, decision support systems, personalized learning, and the evaluation of educator performance. The integration of AI into quality management systems has the potential to strengthen the implementation of TQM by reinforcing the planning, execution, evaluation, and improvement cycle in a more measurable and data-driven manner.

At the preschool level, the use of AI can be directed toward analyzing children's development based on observational data, mapping learning interaction patterns, and providing systematic feedback on teachers' lesson planning and delivery. Thus, the integration of TQM and AI not only improves management efficiency but also strengthens pedagogical quality through objective analytical support. This approach aligns with the demands of educational transformation in the era of the Fourth Industrial Revolution and Society 5.0, which emphasize synergy between technology and human resource development.

However, the integration of AI-based TQM in early childhood education has not yet been comprehensively studied in the educational management literature, particularly in the context of kindergarten.

Most studies still separate the discussion of quality management from the utilization of AI, without integrating both into a single, cohesive conceptual framework. Therefore, an in-depth literature review is needed to formulate a theoretical framework regarding how AI-based TQM can be developed as an innovative quality management model in early childhood education. Based on the above discussion, this article aims to conceptually examine the development of Artificial Intelligence-based Total Quality Management in improving teacher performance and the quality of learning in kindergartens. This study is expected to provide a theoretical contribution to the development of technology-based educational quality management and serve as a foundation for further empirical research on the implementation of AI-based TQM in early childhood education institutions.

RESULT AND DISCUSSION

Total Quality Management in education is rooted in the principles of quality management developed by figures such as W. Edwards Deming and Armand V. Feigenbaum. Deming emphasized the importance of the PDCA cycle (Plan-Do-Check-Act) as a mechanism for continuous improvement, while Feigenbaum introduced the concept of total quality control, which involves all components of an organization. In the educational context, TQM is interpreted as a systematic effort to improve the quality of learning processes and outcomes through effective leadership, a collaborative organizational culture, and data-driven decision-making.

At the kindergarten level, implementing TQM requires quality management that is adaptable to the developmental characteristics of young children. The principle of customer focus is interpreted as meeting children's individual developmental needs and ensuring parental satisfaction with educational services. The principle of continuous improvement requires teachers and school administrators to engage in routine reflection on teaching practices. The principle of involving all organizational components emphasizes the importance of collaboration among school principals, teachers, educational staff, and parents.

Teacher performance is a central variable in the preschool education quality system. Preschool teachers are required to possess adequate pedagogical, professional, social, and personal competencies. Within the TQM framework, teacher performance is evaluated not only based on final outcomes but also on the consistency of lesson planning, the quality of interactions with children, the use of meaningful play-based methods, and the ability to conduct authentic assessments. Effective performance evaluation requires a systematic, data-driven monitoring system.

However, many early childhood education institutions still face limitations in managing learning data. Evaluations are often conducted manually and are not comprehensively documented. This hinders in-depth analysis of learning effectiveness. This is where Artificial Intelligence serves as a strategic tool to strengthen TQM implementation.

AI in education encompasses the use of machine learning algorithms, learning analytics, and decision support systems to analyze educational data. UNESCO and the OECD emphasize that AI can enhance the efficiency of educational management and support personalized learning. In the context of early childhood education, AI can be used to analyze children's development based on observational data, identify teachers' learning patterns, and provide automated feedback on lesson planning.

Integrating AI into the TQM system enables a more effective strengthening of the PDCA cycle. In the planning (Plan) phase, historical learning data can be analyzed to design quality improvement strategies. In the implementation (Do) phase, AI systems can monitor learning implementation in real-time. In the evaluation (Check) phase, AI performs performance analysis and identifies quality gaps. In the improvement action phase (Act), data-driven recommendations can be used for teachers' professional development.

This approach also supports evidence-based decision-making in kindergarten management. Principals can use analytical dashboards to monitor teacher performance and children's developmental progress. Teachers receive objective and measurable feedback, thereby systematically fostering a culture of reflection and enhancing professionalism. Thus, AI-based TQM not only enhances management efficiency but also strengthens the quality of the learning process.

Furthermore, the integration of TQM and AI aligns with Indonesia's digital transformation in education, which emphasizes innovation and accountability. The development of technology-based quality systems is in line with the need to enhance the competitiveness of early childhood education institutions in the digital era. Nevertheless, the implementation of AI-based TQM still requires readiness in human resources, digital infrastructure, and policies that support data ethics and security. Conceptually, the development of AI-based TQM in kindergartens can be formulated as a quality management model that integrates the principles of continuous improvement with intelligent analytics systems to support the improvement of teacher performance and learning quality in a systematic, measurable, and adaptive manner to the development of young children.

CONCLUSION

Based on the literature review conducted, it can be concluded that the development of Artificial Intelligence (AI)-based Total Quality Management (TQM) is a relevant, innovative,

and adaptive quality management approach for improving teacher performance and the quality of learning in kindergartens. The integration of AI into the TQM framework strengthens the implementation of continuous improvement principles through systematic data management systems, objective performance analysis, and support for evidence-based decision making.

AI-based TQM enables the optimization of the quality management cycle—from the planning (plan), implementation (do), evaluation (check), to corrective action (act) stages—through the utilization of analytical systems and intelligent technologies. In the context of early childhood education, this approach contributes to enhancing teacher professionalism through the provision of data-driven feedback, the strengthening of a reflective culture, and more accurate and measurable monitoring of children's development. Consequently, the quality of learning can be substantially improved through the simultaneous enhancement of pedagogical and managerial processes.

Theoretically, this article contributes to the development of educational quality management studies by integrating the TQM paradigm and AI-based digital transformation into the context of early childhood education. This integration broadens the perspective of quality management from a conventional administrative approach toward a systemic model based on data and intelligent technology. This conceptualization can serve as a foundation for developing a digital quality management model in early childhood education institutions in the era of the Fourth Industrial Revolution and Society 5.0.

Practically, the development of AI-based TQM has implications for school principals and kindergarten administrators in establishing a more objective, structured, and sustainable system for monitoring and evaluating teacher performance. Teachers can utilize analytical data as a basis for reflection and professional competency development. Additionally, educational institutions need to prepare technological infrastructure, enhance educators' digital literacy, and establish adequate data protection policies to support the ethical and responsible implementation of AI-based quality systems. Thus, AI-based TQM is not merely a technological innovation in education, but a paradigm shift in quality management oriented toward systematically, sustainably, and data-driven improvements in early childhood learning quality. This model warrants further development through empirical research to test its effectiveness in the context of real-world implementation in kindergartens.

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