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Dynamic Synergy Between Strategic Management and Augmented Reality Technology in Education System Transformation

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A B S T R A C T

This study explores the dynamic synergy between strategic management and Augmented Reality (AR) technology in transforming the education system in the digital era. Through a comprehensive literature review, the research reveals the proven effectiveness of AR in increasing student engagement by up to 70% and enhancing conceptual understanding through immersive learning experiences. However, the adoption of AR in Indonesia faces complex challenges such as digital infrastructure gaps, policy fragmentation, and limited teacher technological readiness. Strategic management acts as a catalyst through visionary planning, resource allocation, and continuous evaluation. Key strategies include curriculum integration, teacher training, infrastructure investment, and multi-stakeholder collaboration.

Keywords: *Augmented Reality, Strategic Management, Educational Transformation, Digital Learning.*
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INTRODUCTION

The development of digital technology has brought significant changes in various sectors, including education. One of the outstanding innovations is Augmented Reality (AR), which is a technology that combines the real world with digital elements so that it is able to create a more interesting and effective learning experience. However, the success of AR integration in the education system does not only depend on the sophistication of its technology, but also on strategic management that is able to optimally manage resources, infrastructure, and learning processes.

The rapid development of information and communication technology in the era of the Industrial Revolution 4.0 has had a significant impact on various aspects of life, including in the field of education. Educational transformation requires not only the adoption of technology as a learning medium, but also the strategic integration of it in the entire learning system to respond to global challenges and the needs of the 21st century. One of the innovative technologies that is now a concern in the world of education is **Augmented Reality (AR),** a technology that combines the real world with virtual elements in real-time.

AR technology has great potential in creating a more interactive, engaging, and immersive learning environment. Research conducted by Bower et al. (2020) shows that the use of AR in the learning process is able to increase student engagement by up to 70%. This is in line with the research of Garzón et al. (2020), which stated that as many as 83% of studies on the application of AR in education showed an increase in student motivation and active participation. AR can enrich the learning experience by presenting three-dimensional objects, dynamic simulations, and interactivity that encourage exploration-based learning and hands-on experiences.

However, the adoption of AR technology in the context of Indonesian education is still faced with various complex challenges. Studies from Van Dijk (2020) and Chen et al. (2017)

show that Indonesia is still lagging behind in digital infrastructure readiness and human resource competence compared to neighboring countries such as Malaysia and Singapore. At the national level, this challenge is further exacerbated by policy fragmentation between stakeholders, limited internet access in 3T areas (frontier, outermost, and disadvantaged), and low technological literacy among educators. This is strengthened by the findings of the Ministry of Education and Culture (Kemendikbud, 2021), which states that there are still many teachers who have not been able to optimize the use of ICT in the learning process effectively.

In this context, **strategic management** has a crucial role as a catalyst for change. Strategic management in education not only aims to manage resources, but also functions in building visions, formulating policies, and directing all elements of the institution to achieve sustainable digital transformation goals. According to Mintzberg et al. (2003), an effective strategic management approach includes visionary planning based on needs analysis, proportionate allocation of resources, and the implementation of a data-driven performance evaluation system. In the context of education in Indonesia, this strategy can be an important foundation in the development of adaptive and contextual AR integration policies.

A literature study conducted by Gunawan (2023) and Jailani (2023) shows that strategic management approaches can strengthen synergy between technology and education through the development of AR-based curriculum, intensive training for teachers, the provision of adequate digital infrastructure, and multi-stakeholder collaboration between schools, government, industry, and technology developers. For example, research by Sari et al. (2023) found that the application of AR in science learning at the elementary school level can significantly improve students' understanding of abstract concepts, but still requires support from school management in the provision of tools and teacher training.

Furthermore, the implementation of AR that is integrated with the strategic framework will prevent the adoption of technology that is symbolic or unsustainable. Joo et al. (2016) show that 68% of education technology projects in Asia fail to have a systemic impact due to the absence of a mature and structured implementation plan. This phenomenon also occurs in Indonesia, where many education digitalization initiatives stop at the pilot project stage due to the lack of long-term policy support and low participation of local stakeholders (Kurniawan, 2022).

Through this qualitative literature study, the researcher seeks to examine in depth the synergy between strategic management and AR technology in the transformation of the education system in Indonesia. This research will identify effective implementation strategies, the main challenges faced, and potential impacts on improving the quality and relevance of national education. It is hoped that the results of this research can make a real contribution to the development of technology-based education policies that are more inclusive, adaptive, and sustainable.

In this context, strategic management plays an important role in designing policies, organizing resources, and overseeing the implementation of new technologies to align with modern educational goals. The synergy between strategic management and AR technology is needed to drive the transformation of the education system towards learning that is more interactive, personalized, and relevant to the needs of the 21st century(Aslamiah et al., 2021). Moreover, the industrial revolution 4.0 has accelerated the transformation of the global education system towards an interactive and inclusive digital model, where AR is a catalyst for immersive learning innovation.

Review of literature

The integration of strategic management and Augmented Reality (AR) technology in education requires a systematic approach based on contemporary theoretical frameworks. Strategic management in the context of the digital transformation of education must include not only formal planning but also adaptive ability to respond to rapid technological changes (Matos et al., 2025) . The strategic agility approach is crucial in overcoming the technology gap and the demands of 21st century learning (Cates, 1995) (Daerah et al., 2024). The Resource-Based View theory explains that the success of AR implementation depends on three main factors: (1) the availability of valuable resources such as ICT infrastructure and relevant AR

content, (2) the organization's capabilities in managing change, including teacher training and the development of a culture of innovation, and (3) the ability of the institution to continuously evaluate and adapt to the latest developments.

In the SWOT analysis, the implementation of AR is faced with the complexity of challenges and opportunities. Recent studies show that AR can improve experiential learning (Radu, 2014) and student motivation by up to 70% compared to traditional methods (Sugiono, 2021) (Garzn et al., 2019). However, research by Chen et al. (2017) revealed that the high cost of AR content development and reliance on hardware are major obstacles, especially in developing countries such as Indonesia (Ajizah, 2021). On the other hand, the Freedom to Learn policy and potential partnerships with the technology industry open up significant opportunities for accelerating the adoption of AR. The main challenge comes from the human factor, where teachers' resistance to technological change (technostress) is still an obstacle based on the findings (Dalle et al., 2021)

Rogers' (2003) Innovation Diffusion Theory provides an important framework in analyzing the factors influencing the adoption of AR. Recent research by Garzón et al. (2020) shows that the success of AR implementation is highly dependent on five characteristics of innovation: relative superiority, compatibility, complexity, testability, and observability of results (Endarto & Martadi, 2022). The findings of Bower et al. (2020) reinforce that schools with mature ICT infrastructure are twice as successful in adopting AR. However, in Indonesia, which faces a digital divide.

Evaluation of AR implementation requires a comprehensive approach by modifying the Balanced Scorecard (Kaplan & Norton, 1996). The learning perspective needs to measure the increase in student engagement, while the internal process aspect needs to evaluate the efficiency of teaching time. The challenge of the digital divide that has the potential to widen education inequality must be addressed through a hybrid approach that combines top-down policies and bottom-up initiatives (Farhan et al., 2024).

Strategic solutions must be implemented immediately such as teacher training for learning transformation (Moh abdul fattah, 2023). Recent research recommends pilot projects based on action research and collaboration between academia, industry, and government. A holistic approach that combines technological, pedagogical, and managerial aspects is the key to the success of AR integration in Indonesia's complex education ecosystem (Lazwardi & Prince, 2025).

METHOD

The research method used in this study is an in-depth literature study, which includes the review of various articles, journals, and reports related to strategic management and Augmented Reality (AR) technology in education. A qualitative approach was chosen to explore the synergistic relationship between the two aspects and their implications for the comprehensive transformation of the education system (Jailani, 2023).

This literature review includes a critical analysis of a range of relevant sources, including previous research that addresses the application of AR in educational contexts, as well as strategic management theories that can be applied in technology integration. This approach is in line with Gunawan's (2023) research which confirms that literature studies allow for an in-depth understanding of the benefits, challenges, and impacts of AR on students' learning experiences. In addition, this research will also identify effective strategies for the integration of technology in learning, so that it can make a meaningful contribution to the development of education in the digital era.

Using this method, it is hoped that the research can provide a clear and comprehensive picture of how strategic management and AR technology can synergize to drive better educational transformation and more relevant to the needs of the 21st century

FINDINGS AND DISCUSSION

The Role of Strategic Management in AR Integration

Strategic management serves as a framework that not only manages change and innovation, but also directs the development of a technology-integrated curriculum, teacher training, infrastructure investment, and cross-sector collaboration. Research by Arisanti et al. (2024) shows that the structured use of AR in early childhood education is able to increase learning motivation and understanding of abstract concepts. Despite this, its implementation still faces technical obstacles and a lack of teacher training. This emphasizes that systematic strategic management is needed so that AR is not just an additional tool, but an integral part of the adaptive and innovative learning process.

Strategic management also plays a role in creating a clear vision and mission related to the use of AR in education. With clear guidelines, educational institutions can more easily formulate policies and strategies that support AR integration. For example, the development of a curriculum that accommodates AR technology should be done by involving a variety of stakeholders, including teachers, students, and parents, to ensure that all parties understand the benefits and goals of using this technology (Sari et al., 2023).

Effective Strategies in the Utilization of AR

The literature shows that there are various effective strategies in the use of AR that can be adopted by educational institutions. Sari et al. (2023) found that AR integration provides a powerful visual and sensory stimulus, which significantly increases student engagement, satisfaction, and motivation. Gunawan (2023) emphasized the importance of developing an AR-based curriculum that is contextual and relevant to the needs of the industry and students. This shows that a curriculum designed with the needs of the world of work in mind will be more attractive to students and can increase the relevance of education.

Intensive training for teachers is also one of the key strategies. Without an adequate understanding of how to operate and integrate AR in learning, teachers may struggle to utilize this technology effectively. Therefore, a continuous and structured training program is essential to ensure that teachers have the necessary skills (Pujiastuti et al., 2020).

Adequate infrastructure investments, including hardware and stable internet networks, are also an important factor in the success of AR integration. The availability of adequate technology will allow students and teachers to access AR content easily and without barriers. Cooperation between schools, industry, and technology developers is also critical to support innovation and relevance of learning materials. With this collaboration, educational institutions can develop AR content that suits the needs of students and the world of work.

The Impact of Strategic Management and AR Synergy

The impact of synergy between strategic management and AR technology in education is significant. The implementation of AR has been proven to improve student motivation, concept understanding, and learning outcomes through visualization of material in 3D form that is interactive and easily accessible (Zulfikhar et al., 2024). AR creates a more engaging and enjoyable learning experience, thereby encouraging improved learning quality and learning outcomes (Zulfikhar et al., 2024). Further, the literature reveals that AR integration can strengthen student engagement, learning motivation, and the development of much-needed 21st-century skills in the digital age (Suriansyah et al., 2020). With proper strategic management, the implementation of AR can run in a directional and sustainable manner, so that the transformation of education is not only technological, but also touches on aspects of quality and equity in education.

In addition, the challenges faced in the implementation of AR, such as high development costs, limited digital literacy among educators and students, and infrastructure constraints, especially in areas with limited resources, are major concerns. Therefore, a comprehensive and collaborative managerial strategy is needed between governments, educational institutions, and technology developers to overcome these barriers. Support in the form of subsidies for the procurement of AR devices, continuous training for teachers, and the development of adequate digital infrastructure are strategic steps that must be taken so that AR can be accessed equally and effectively2. The development of AR content that is relevant to industry needs and can be widely adapted is also a key factor in the successful integration of this technology in vocational and formal education

Recent research proves that the implementation of Augmented Reality (AR) in education is able to significantly increase student engagement. A comprehensive study conducted by Bower et al. (2020) of 62 AR educational experiments in different countries found an average increase of 70% in student engagement compared to traditional learning methods. Similar findings were revealed in a meta-analysis of Garzón et al. (2020) who analyzed 61 AR implementation studies, in which 83% of the studies reported a significant increase in student motivation and active participation. The psycho-pedagogical mechanism behind this phenomenon is explained by Radu (2014) through the cognitive-affective learning theory, where AR creates an immersive learning experience that simultaneously stimulates the cognitive and emotional aspects of students.

Despite its empirically proven transformative potential, AR adoption in Indonesia still faces complex challenges. Research conducted by Van Dijk (2020) identified three main structural barriers: (1) policy fragmentation between various education stakeholders, (2) digital infrastructure gap between urban and rural areas, and (3) human resource competency gap in managing cutting-edge educational technology(Cullen, 2001) . A comparative study by Chen et al. (2017) in Southeast Asia shows that Indonesia is 3-5 years behind in the adoption of educational technology compared to Malaysia and Singapore, especially in terms of infrastructure readiness and teacher capacity.

In this context, the implementation of strategic management is an absolute prerequisite for the success of AR integration. The framework proposed by Mintzberg et al. (2003) emphasizes the need for a holistic approach that includes three critical dimensions: (1) visionary planning based on real needs assessment, (2) proportional resource allocation taking into account the value for money principle (Porter, 2001), and (3) data-driven sustainable evaluation systems (Kaplan & Norton, 1996). The international experience documented by Bower (2020) proves that educational institutions that successfully integrate AR are those who make it part of a long-term strategic plan, not just an incidental project.

Without a solid strategic management framework, AR implementation risks becoming a fragmented and unsustainable intervention. Action research by Joo et al. (2016) in various Asian schools shows that 68% of educational technology initiatives fail to achieve systemic impact due to the absence of a structured implementation framework. The theory of institutional isomorphism (DiMaggio & Powell, 2000) explains how institutional pressures often drive schools to adopt technology without a clear strategy, just to pursue the impression of modernity. Therefore, a systemic approach that integrates AR into the entire educational ecosystem - from curriculum, pedagogy, to evaluation systems is a necessity to achieve meaningful and sustainable educational transformation.

CONCLUSIONS

Based on a literature review, the synergy between strategic management and Augmented Reality (AR) technology plays an important role in the transformation of education in the digital era. AR has been shown to significantly increase student engagement and understanding through immersive learning. However, its implementation in Indonesia is still hampered by infrastructure gaps, fragmented policies, and low teacher competence. Strategic management plays a vital role in designing visionary planning, resource allocation, and continuous evaluation. A holistic approach that combines technology, pedagogy, and governance—and supported by inter-institutional collaboration—is key to the success of systematic AR integration towards relevant and sustainable education.

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