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Inhibiting factors of metaverse adoption in Indonesian education: A literature review

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ABSTRACT

Science is always evolving, and education and technology are no exception. As science develops, education and technology become an integrated whole. In the era of technological development 5.0, a new term has now been recognized, namely 'metaverse'. This research aims to examine the issues in the form of challenges from the metaverse that are being faced by the realm of education in Indonesia. This research is useful for educational actors in Indonesia to understand the urgency in answering the challenges of this metaverse technology. The research method used is the Systematic Literature Review (SLR) method where as much information as possible is collected and then interpreted in depth. The findings of this research are that there are technical challenges such as infrastructure availability, sustainability of technology use, institutional support, teacher and learner readiness, and community roles that hinder the integration of metaverse in the learning process. The key factors that need to be considered to implement Metaverse in education include psychological and motivational, quality, social, and inhibiting factors. The findings can be a motivation for readers in finding solutions to the integration of metaverse in the realm of education itself.

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ABSTRAK

Ilmu pengetahuan selalu mengalami perkembangan, tak terkecuali di bidang pendidikan dan teknologi. Seiring berkembangnya keilmuan, pendidikan dan teknologi menjadi suatu kesatuan yang saling terintegrasi. Pada era perkembangan teknologi 5.0 kini telah dikenal istilah baru yakni 'metaverse'. Penelitian ini bertujuan untuk mengkaji isu berupa tantangan dari metaverse yang tengah dihadapi ranah pendidikan di Indonesia. Penelitian ini bermanfaat bagi para pelaku pendidikan di Indonesia untuk memahami urgensi dalam menjawab tantangan dari teknologi metaverse ini. Metode penelitian yang digunakan adalah metode Systematic Literature Review (SLR) dimana dilakukan pengumpulan informasi sebanyak-banyaknya untuk kemudian ditafsirkan secara mendalam. Temuan dari penelitian ini adalah terdapat tantangan-tantangan teknis seperti ketersediaan infrastruktur, keberlanjutan penggunaan teknologi, dukungan institusi, kesiapan guru dan peserta didik, serta peran komunitas yang menghambat integrasi metaverse dalam proses pembelajaran. Adapun faktor-faktor kunci yang perlu diperhatikan untuk menerapkan Metaverse dalam pendidikan mencakup psychological and motivational, quality, social, dan inhibiting factors. Temuan ini dapat menjadi motivasi bagi pembaca dalam menemukan solusi atas integrasi metaverse dalam ranah pendidikan itu sendiri.

Kata Kunci: *faktor penghambat; metaverse; pendidikan*

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INTRODUCTION

The term Metaverse itself is not a new concept. The idea of Metaverse has existed for several decades (Sra et al., 2022). It originated from a novel by Neal Stephenson published in 1992, where Metaverse was described as a form of shared virtual reality (De Felice et al., 2023). However, at that time, the concept of Metaverse had not yet been fully developed. It was only thirty years later that Metaverse began to have a clear definition. Mark Zuckerberg successfully re-popularized the term and concept of "Metaverse" to the public through the transition of the social media platform Facebook into Meta.

The concept of Metaverse, as widely understood today, relates to activities commonly carried out in the real world that can now be performed in the virtual world—such as socializing, shopping, and even engaging in teaching and learning activities with fellow users. More specifically, Indrabayu et al. (2022) describe Metaverse as a form of digital technology development that can create a three-dimensional virtual world through the utilization of Augmented Reality (AR) and Virtual Reality (VR), thereby enabling interactions that feel almost real within the virtual or digital realm. The rapid advancement of Metaverse has significantly influenced various aspects of life, one of which is the field of education.

The use of technology in education has shown considerable progress; today, education has expanded its learning scope through the introduction of the metaverse concept as a new potential within the educational domain (Putri et al., 2022). Metaverse, as a virtual environment, offers an immersive digital experience and an opportunity to transform the teaching and learning paradigm in Indonesia. The implementation of metaverse in the educational sphere is an intriguing endeavor, as it can build and create interactive and profound learning experiences for both students and teachers (Yuda et al., 2024) However, the application of metaverse in the context of Indonesian education still faces several challenges that need to be thoroughly understood (Indarta et al., 2022).

Several studies have identified key factors that influence the implementation of Metaverse in both global and local educational contexts. A previous study conducted by Gusteti et al. (2023) revealed several obstacles hindering the achievement of improved teaching and learning concepts through the use of Metaverse. The aspects discussed in this study tend to highlight technical issues, such as the availability of infrastructure, sustainability of technology use, institutional support, teacher readiness, and the role of the community in utilizing Metaverse—all of which remain challenges that hinder its integration into the learning process. Similar findings were presented in the research conducted by Indarta et al. (2022), which pointed out that the implementation of Metaverse in education faces challenges related to the social conditions of society, resulting in unequal accessibility to Metaverse technology. The application of Metaverse as a learning strategy is also influenced by several important factors. Trisnawati (2024) in her research, stated that one of the factors affecting the selection of effective learning strategies is the level of technological readiness in the learning environment. From these three studies, it can be concluded that technological factors play a crucial role in the implementation of Metaverse in the field of education.

In general, the use of Metaverse in Indonesia has been widely applied across several key sectors. In the economic sector, a study by Fauzan dan Priowirjanto (2023) on the use of Metaverse in online business found that its impact on online business activities and their regulation in Indonesia is positive—providing convenience for sellers and buyers in conducting transactions and communicating within the virtual world. Its use in other sectors is evident in tourism; research by Putra et al. (2023) stated that the presence of Metaverse has a significant influence on Indonesian tourism. It was mentioned that Metaverse offers a more interactive travel experience and has the potential to become an innovation in emerging tourism trends. However, this also comes with certain threats. Putra et al. (2023) also noted that such threats may arise due to the uneven distribution of internet access in Indonesia, which could hinder optimal utilization. On the other hand, in the education sector in Indonesia, the use of Metaverse has been increasingly adopted at various educational levels. Research by Safaruddin et al. (2024) highlighted the use of Gather

Town in supporting enjoyable and interactive learning for teachers and students at the elementary school level. Another study conducted by Alinata dan Marsudi (2023) demonstrated the use of Roblox as a medium for promoting Metaverse schools.

Based on the explanation above, the researchers recognize the need for further study to categorize the dominant factors influencing the implementation of Metaverse in education in Indonesia. Therefore, the research problem in this study will focus on identifying the key factors that affect the application of Metaverse in Indonesian education. The purpose of this article is to present a comprehensive synthesis of the inhibiting factors in the implementation of Metaverse in Indonesian education, based on a review of recent literature. This article is expected to provide valuable insights for education stakeholders in identifying solutions and strategic steps to facilitate the use of Metaverse in the educational process in Indonesia.

LITERATURE REVIEW

Metaverse Concept

The rapid advancement of the digital world is evidenced by the emergence of a technology that provides a digital space where we, as users, can enter using an avatar—this technology is called metaverse. As a result of technological development, Metaverse can also give rise to a new technological revolution. Metaverse is one of the technologies that offers its users the opportunity to explore a virtual world filled with digital objects and other users, create avatars that reflect their real-world identities, and generate digital objects and digital spaces to meet their needs (Chai et al., 2023).

Metaverse integrates 3D technology with elements from the real world, creating a domain where users can experience interactions similar to those in everyday life. In the Metaverse, digital objects are not merely graphic representations; they appear with a high level of realism, allowing users to interact in a more natural and lifelike manner (Setyowati et al., 2023).

Application of Metaverse in the Field of Education

The development of Metaverse has now extended into the field of education. The presence of Metaverse enables education without the limitations of space and time. Its use in the educational realm allows online learning to become interactive without compromising the learning experience. Currently, educational institutions are facing global competition, and the quality of education has become the main criterion that distinguishes the best. By utilizing Metaverse—a shared virtual space created through the combination of virtual and augmented reality, physics simulation, and the internet—students' learning experiences can become more interactive and enjoyable. Thus, Metaverse technology can serve as one way to improve the quality of education and enhance learners' competencies and skills (Indarta et al., 2022).

Technological Infrastructure and Accessibility Limitations in Indonesian Education

The use of technology in Indonesia's education sector has brought significant impacts, encompassing aspects of access, quality, and social equity. Various technological advancements in education—such as the implementation of e-learning, development of learning media, availability of access, quality of instruction, and social equity—have become essential foundations for improving the country's education system. Nevertheless, the application of educational technology still faces several challenges that need to be addressed. Accessibility barriers, especially in remote areas, remain a major issue. The lack of teacher preparedness in utilizing technology in the teaching process and the shortage of high-quality educational

content are also key obstacles. Therefore, supporting adequate infrastructure, developing teaching materials that align with labor market demands, and designing effective learning strategies are crucial to optimizing the benefits of technology in the teaching and learning process (Hidayatullah et al., 2023).

METHODS

The method used in this study is the Systematic Literature Review method. This SLR method is a research approach aimed at collecting and evaluating research findings that are relevant to specific topics. In addition to collecting and evaluating, the SLR research method also aims to identify, examine, and interpret research literature related to a particular phenomenon.

The Systematic Literature Review method consists of several stages (1) identifying the purpose of the review and the types of supporting evidence, (2) searching for literature, (3) setting criteria, (4) synthesizing evidence, and (5) drawing conclusions from the review results. The stages carried out in this study include: (1) determining the research objectives; (2) searching for articles with the topic criteria “metaverse dalam pendidikan” published within the last five years (2019–2024); (3) analyzing the articles; (4) presenting the analysis results in table form; and (5) describing the findings in a descriptive manner.

The articles analyzed in this study were obtained from academic databases such as Google Scholar, Scopus, and Crossref. The criteria for selecting articles included publication within the last five years (2019–2024) and full accessibility (open access). The selection of articles for analysis was also influenced by keywords that indicated the topic of study in the respective articles. Abstracts were also reviewed to ensure that the content of the articles aligned with the topic “metaverse dalam pendidikan.”

RESULTS AND DISCUSSION

The following table presents the results of a review of previous research articles discussing the obstacles to implementing Metaverse in Indonesian education.

Table 1. Review Results of Previous Articles

No	Source Reference	Article Review Findings
1	Metaverse Dan Tanggung Jawab Akademisi Dalam Pendidikan Desain Komunikasi Visual (Arifianto et al., 2022)	From the perspective of Desain Komunikasi Visual (DKV) education, the use of Metaverse is considered to inadequately accommodate the humanistic aspect, posing significant challenges for involved academics. To address this issue, the presence of ethical boundaries implemented through regulations such as laws governing the use of Metaverse in educational contexts is required.
2	Metaverse Dan Pembelajaran Sejarah Kebudayaan Islam Di Madrasah; Tantangan Dan Peluang (Fauzian, 2022)	Challenges in applying Metaverse to the subject of Studi Kebudayaan Islam (SKI) in madrasahs include technological and economic access limitations experienced by both educators and students. In this context, further research is needed to explore the digitalization of education in the Metaverse era, particularly concerning the teaching of Islamic history and culture.
3	Keamanan Data Pribadi pada Metaverse (Munawar et al., 2022)	The most critical threat in Metaverse technology is the risk to privacy and personal data security, which is often associated with technical domains. It is essential to conduct more comprehensive research on the technical aspects of Metaverse through the lens of social sciences and humanities.

No	Source Reference	Article Review Findings
4	Era Meraverse dan Tuntutan Teknologi Pembelajaran Adaptif (Tapung, 2023)	There are numerous demands in implementing adaptive learning technologies, including internet access gaps, ethical usage, personal security, and the social impacts that arise during the learning process. It is important for teachers to understand the urgency and potential of adaptive learning that utilizes Metaverse technology for a better future in education.
5	Pengembangan Sistem Pembelajaran Siswa Berbasis Metaverse pada TK Islam Pelita Insan (Maulana et al., 2023)	During a training session held at TK islami pelita, teachers were trained to use a learning website application based on Metaverse technology. By using Metaverse, online learning began to feel more like offline learning. However, comprehensive training is needed to enable teachers to design Metaverse-based learning effectively. In addition, the availability of supporting facilities remains insufficient and needs to be provided to realize Metaverse-based education.
6	Pembelajaran Berbasis Metaverse - Virtual Reality Menggunakan Spatial.io dengan Model Discovery Learning untuk Meningkatkan Pemahaman dan Minat Siswa (Rasyida et al., 2023)	The use of Metaverse in the subject of Informatika has shown positive results, proving effective in increasing students' interest and fairly effective in improving their cognitive learning outcomes.
7	Big data and metaverse toward business operations in indonesia (Depari et al., 2022)	In the use of big data and Metaverse, various obstacles arise, including internet infrastructure, technologies related to VR or AR, human readiness to adapt, and others. When Metaverse relies on virtual reality technology and data centers, reduced physical movement may lower carbon dioxide emissions, but it also has negative environmental impacts. Data centers use artificial intelligence to detect eye and hand movements, yet virtual reality depends heavily on cloud services. Such factory operations require enormous amounts of energy and are extremely costly to the environment.
8	The Potential of Metaverse Technology in Education as a Transformation of Learning Media in Indonesia (Wijayanto et al., 2023)	The use of Metaverse as an interactive medium presents opportunities for it to serve as a learning platform in the field of education. These opportunities include immersive interactive experiences, visualization, lower risks and costs, unlimited space and time, prevention of academic violations, personalization, and enhanced communication. However, potential challenges may arise in the form of the absence of boundaries for participants, leading to physical inactivity and other neutral forms of interaction.
9	Visualization and Cybersecurity in the Metaverse: A Survey (Chow et al., 2022)	In the use of Metaverse, identity theft, privacy issues, and physical threats are major concerns within the context of visualization technology. This article also outlines potential countermeasures, including XR authentication methods, AI-based cybersecurity techniques, continuous authentication, and automated detection and mitigation.
10	How Does the Metaverse Shape Education? A Systematic Literature Review (De Felice at al., 2023)	Metaverse holds potential for bringing innovation to education, particularly in fields that require practical training and hands-on experience. The full potential of Metaverse can be realized through collaboration to create a safe and open environment, along with effective technological adaptation.
11	Metaverse and education: the pioneering case of Minecraft in	An analysis was conducted on the idiosyncratic characteristics of Minecraft to be applied as an educational platform, and it is viewed as a foundational exercise for engaging with the Metaverse. The results indicate that the Minecraft platform can strengthen

No	Source Reference	Article Review Findings
	immersive digital learning (Sánchez-López et al., 2022)	educational approaches and align them with digital environments. Minecraft offers differential components such as avatars and game mechanics that can be applied in digital learning processes.
12	Education metaverse: Innovations and challenges of the new generation of Internet education formats (Zhai et al., 2022)	This study presents a critical reflection on the challenges arising from the use of Metaverse in education. These challenges include data maintenance, digital copyright, and capital for accessibility to digital education models.
13	Lessons Learned during COVID-19 and Future Perspectives for Emerging Technology (Guzzo et al., 2023)	As an immersive technology, Metaverse holds the potential to create engaging and interactive learning experiences, encouraging interaction and collaboration among students.
14	Prototype Curriculum: Opportunities and Challenges of Inclusive Schools in Implementing Education for All in the Metaverse Era (Bakhri & Sofyan, 2022)	The implementation of prototype curricula in special schools or specialized learning environments focuses on the development of students' soft skills and character. The growing advancement of Metaverse technology may influence the implementation of inclusive education by providing better accessibility for students with special needs.
15	Is Metaverse in education a blessing or a curse: a combined content and bibliometric analysis (Tlili et al., 2022)	The design of Metaverse in education has evolved across generations. For Generation Z, artificial intelligence (AI) technology has become the central focus. Findings from this study indicate that the implementation of Metaverse can expand educational opportunities by enabling exploration of limited environments due to constraints such as space, time, and cost.
16	Definition, roles, and potential research issues of the metaverse in education: An artificial intelligence perspective (Hwang & Chien, 2022)	The features available in Metaverse can serve as learning support for robust training programs. The opportunity to create training formats for students in digital form within the Metaverse offers access to those who may not be able to experience them in the real world.
17	The rising trend of Metaverse in education: challenges, opportunities, and ethical considerations (Kaddoura & Al Husseiny, 2023)	The existence of a virtual world in the form of Metaverse allows learning approaches to be developed more broadly. It offers students and teachers alternative ways to conduct the teaching and learning process by combining two learning models (hybrid). The advantages of Metaverse in education include introducing new styles and methods of learning that can contribute more effectively. However, its drawbacks are largely related to infrastructure, ethical concerns, and mental health issues.
18	The expanding role of metaverse platform in college education (Lee et al., 2022)	By using Zepeto, a Metaverse classroom has been created and utilized for teaching and learning, with instructional activities conducted among classroom avatars. Through the use of Metaverse platforms in online education, student satisfaction has increased due to active interaction and communication via avatars.
19	Game-based learning in metaverse: Virtual chemistry classroom for chemical bonding for remote education (Rahman et al., 2024)	The implementation of VC3B as both a learning medium and a game-based learning approach has significantly improved students' understanding of chemical bonding and chemical formulas. The combination of gamification elements, interactive gameplay, and feedback has led to increased motivation and active student participation.

No	Source Reference	Article Review Findings
20	Metaverse system adoption in education: a systematic literature review (Alfaisal et al., 2022)	The Technology Acceptance Model (TAM) is widely recognized as the most frequently used model for predicting an individual's intention to support Metaverse systems. In addition, SmartPLS (PLS-SEM) has been identified as a commonly used tool for validating Metaverse models. The primary focus of many reviewed studies is to explore how students adopt or accept Metaverse systems and the technologies that support them.

Source: Research 2023

Discussion

Metaverse represents a digital revolution in education. This article discusses the acceleration of technology used in education, particularly since the outbreak of COVID-19. Although Metaverse technology can overcome spatial limitations, the challenge of direct social interaction remains. The lack of social interaction limits the transfer of knowledge and moral values from teachers to students, often causing students to lose focus and neglect behavioral aspects during learning.

In adapting or implementing Metaverse into the educational realm, many aspects must be considered. Maghaydah et al. (2024) in their study, identified key factors that may influence the adoption of Metaverse in education, namely:

1. Psychological and motivational factors
   This factor refers to the psychological condition and motivation of individuals using Metaverse in education. More specifically, it encompasses attitudes, personality, beliefs, thoughts, and emotions when engaging with Metaverse. The importance of this factor lies in its influence on individual responses during the learning process using Metaverse, which in turn affects the overall concept of Metaverse implementation.

2. Quality factors
   The quality factor refers to the quality of information, service, and system within a Metaverse. User experience and perceptions of Metaverse quality significantly impact its acceptance and continued use. The better the quality of the Metaverse, the more effective its application will be in educational environments.

3. Social factors
   The social factor refers to an individual's actions that can influence the behavior and decisions of others within a social group regarding the use of new technologies, specifically Metaverse. This social factor can affect how Metaverse is adopted and utilized as a tool for digital education.

4. Inhibiting factors
   Factors that may hinder the implementation of Metaverse in education include perceived risk and perceived complexity. These two aspects relate to an individual's experience in using technology, particularly Metaverse. The perceived risk involves users' concerns about the security and privacy of personal information, which is considered highly vulnerable in the event of data breaches or misuse. On the other hand, perceived complexity refers to the difficulty of using a certain technology. The more complex it is, the harder it becomes to adapt, potentially leading to a lack of trust in the technology. This implies that promoting the use of Metaverse must be done in the simplest way possible to be more effective.

In addition to the key factors that must be considered in the implementation of Metaverse, greater attention is also needed for the challenges that arise or are anticipated when Metaverse is applied in education. Several challenges that may be encountered in the implementation of Metaverse have been analyzed based on previously collected articles.

The first challenge is the limited access to technology for both students and teachers. Unequal socioeconomic conditions are one of the causes of restricted access to Metaverse technology. Differences in conditions among students create a gap in technology access. The same applies to teachers, where limited access to technology hinders the effective use of technology in the learning process (Subroto et al., 2023). This is supported by the findings of Fauzian (2022) who discovered that the use of Metaverse in subjects cannot yet be considered effective due to technological and economic access limitations experienced by students and teachers. Tapung (2022) adds that limited internet access in the use of Metaverse technology also presents a distinct demand or challenge for adaptive learning. Adaptive learning technology in the Metaverse era offers a pathway to more inclusive and unrestricted education.

The second challenge concerns data security and privacy. Issues related to personal data privacy and protection are among the primary risks in the Metaverse environment. Data theft frequently occurs in cyberspace and can endanger individuals' lives in the real world. This threat to data security and privacy is a critical challenge in the utilization of Metaverse and is often linked to technical domains (Munawar et al., 2022). Chow et al. (2022) also revealed that privacy concerns, data theft, and even physical threats are major considerations in visualization technologies such as Metaverse. These statements are supported by Arrofi et al. (2024) who emphasized that data security is a crucial aspect due to the increasing risks of theft and privacy violations.

The third challenge relates to the quality of infrastructure, including facilities and resources that support the continuity of Metaverse-based learning. There are still significant gaps between schools in terms of providing learning support facilities. Akbar dan Noviani (2019) identified several technological challenges faced by the education sector, including: (1) insufficient provision of infrastructure for equitable use of TIK in certain regions of Indonesia; (2) the use of second-hand devices in educational institutions, particularly in rural areas; and (3) high procurement costs for TIK support facilities. These challenges may arise due to budget limitations that hinder the acquisition and maintenance of technological infrastructure in educational institutions (Subroto et al., 2023).

As a developing country, Indonesia faces serious challenges regarding the gap in access to this technology. Given that Indonesia is a vast archipelagic nation, many remote areas remain underserved and lack adequate internet access. Arifin et al. (2023) added that significant barriers to the use of Metaverse stem from limited internet access, such as slow connections, relatively high subscription costs, and insufficient bandwidth availability. This is supported by Subroto et al. (2023) who stated that one of the major challenges for educational institutions in remote areas is the difficulty in providing adequate internet connectivity.

The fourth challenge concerns the readiness of teachers and students to accept new forms of technology and adapt to using them. Each individual's knowledge and ability to access the latest technology varies. As stated by Maulana et al. (2023) implementing Metaverse in learning requires comprehensive training for teachers, particularly in designing Metaverse-based instruction. However, in reality, many teachers are not yet prepared for this. In their study, Subroto et al. (2023) found that teachers need ongoing comprehensive training to enhance their competence in effectively using technology in the learning process.

The following section discusses the demands of adaptive learning technology in the Metaverse era. Adaptive learning technology in the Metaverse era serves as a pathway toward more inclusive and boundless education. Metaverse technology offers tremendous potential in the educational domain. With

its concept of interactive simulation, Metaverse enhances accessibility for adaptive learning by enabling personalized student learning experiences. Despite these benefits, numerous challenges remain in applying Metaverse to achieve adaptive learning. By understanding the challenges that must be addressed in implementing adaptive learning through Metaverse, educators and policymakers are expected to determine appropriate strategies so that this technology can be utilized effectively (Tapung, 2023).

CONCLUSION

Based on the discussion presented, it can be concluded that the use of Metaverse in Indonesian education offers significant potential to enhance students' learning experiences. However, there are several inhibiting factors that must be carefully considered in integrating Metaverse into the education system. Technical challenges such as infrastructure availability, sustainability of technology use, institutional support, teacher and student readiness, and the role of the community continue to hinder the integration of Metaverse in the learning process. It is essential to conduct further studies to identify the key factors influencing the implementation of Metaverse in Indonesian education. Through a deeper understanding of these barriers, it is hoped that effective strategies can be formulated to facilitate the use of Metaverse in education, thereby improving the quality of learning in Indonesia and making it more adaptive to technological advancements.

AUTHOR'S NOTE

The author sincerely declares that there is no conflict of interest related to the publication of this article. Furthermore, the author affirms that all data and content in this article are original and free from plagiarism.

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