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Digital Transformation In Education Management Optimizing Technology For Effective Learning

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ABSTRACT

The integration of technology in education has now become a necessity. Digitalization in education opens up great opportunities in educational management to optimize effective learning. However, in Indonesia, educational digitalization poses a challenge in terms of equity. This article aims to examine how the digitalization of education management can improve the quality of learning and address the technology usage gap in Papua. This research uses a qualitative descriptive method with a literature review, analyzing various data from books and journals, and applying triangulation to obtain more comprehensive data. The results show that the integration of technology has a significant positive impact on the accessibility and efficiency of learning. However, Indonesia's geography hinders digitalization in all regions, especially in Papua. The remote areas of Papua with many 3T regions still use conventional models due to difficult access, limited internet, and a lack of competent human resources. There is a need for the improvement of human resource quality, the utilization of technology, and collaboration with the government and non-profit organizations.

INTRODUCTION

The development of education has evolved significantly, especially with the integration of technology in the 4.0 era. Education management, which involves organizing processes from planning to evaluation, aims to ensure that educational objectives are met effectively (Thomassen & Jørgensen, 2021). With the rise of digital technologies, strategies for improving the learning process have expanded. One key approach is the digitization of education, which enhances accessibility and learning

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efficiency (Luengo-Aravena et al., 2024). For example, Indonesia's Ministry of Education and Culture has launched various platforms like Rumah Belajar

, educational TV, and educational radio, making educational materials accessible to a broader audience (Monroy-Gómez-Franco et al., 2022). These initiatives demonstrate how technology can break down barriers in education, providing resources to communities regardless of location (Subroto et al., 2023). Additionally, the digital revolution in education management has led to the development of applications that support personalized student learning and improve administrative efficiency (Web Manager, 2020). This shift highlights how technology is reshaping education to be more inclusive and adaptive (Tarei et al., 2021).

The level of technology use in education in Indonesia shows a significant increase. based on the Central Statistics Agency (BPS) report in 2023, it provides a percentage of around 59.33% of students aged 5-24 years using internet access for learning activities. This percentage increased by 33.98% from 2016 (Oke & Fernandes, 2020). The increase in internet usage increased at all levels of education, at the elementary school level internet usage as of 2020 reached 35.97%, junior high school 73.4%, high school 91.01% and higher education 95.3% (Central Bureau of Statistics, 2023). In addition, according to (Simon Kemp, 2023; Wati Sukmawati, et.al, 2023), around 77% of the total population in Indonesia uses internet access in all aspects. (Sharma et al., 2022), This means showing that the use of technology has become an important component in the education system or management as well as in all aspects of life.

The purpose of this article is to highlight the importance of education following the development of the digital revolution where the use of technology in education is no longer an option, but a necessity. Although the digital revolution can optimize learning, challenges such as accessibility gaps and limited technological infrastructure are still obstacles. Based on the 2023 BPS report, internet use for learning activities in Indonesia has shown a significant increase, but access to technology in remote areas is still limited. This paper aims to explore the role of technology in improving the learning process and educational management, as well as identifying the efforts needed to overcome access gaps and improve technology infrastructure. Apart from that, this article also wants to highlight how geographical factors can influence the distribution of technology and internet access, as well as the importance of infrastructure development to create more inclusive and effective education throughout Indonesia.

Research on the integration of technology into education management shows that technology can help improve learning outcomes in a variety of ways. For example, technology enables distance learning, access to a wider range of materials, and personalization of learning. Given the uneven state of digitization of education in Papua, especially in rural areas in terms of infrastructure, low quality of educators and accessibility of technology, to maximize the benefits of technology in education in

Papua, further efforts are needed to improve infrastructure, training to increase resource competencies, and ensure equitable access to technology throughout Indonesia.

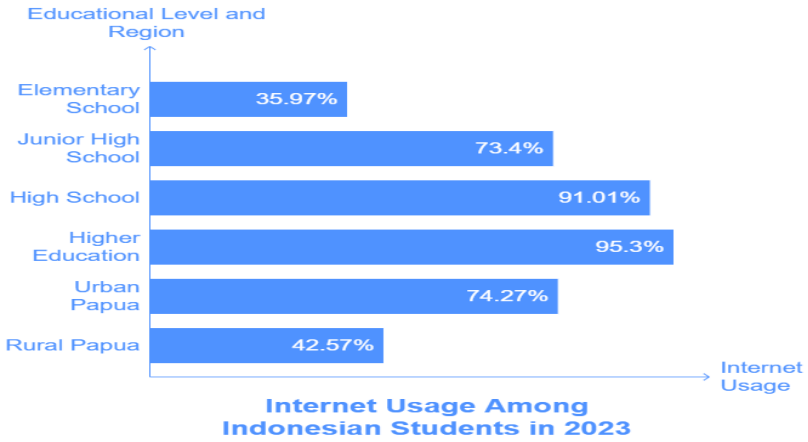
RESEARCH METHODS

The methodology implemented in this research applies a qualitative paradigm with a descriptive orientation. The paradigm was selected to comprehensively explore and elaborate phenomena in line with the context of the object of analysis (Moleong & Surjaman, 2007). The research design adopted a systematic literature review approach that accommodated the integration of various sources of academic literature, including scientific journal articles, textual references, and formal documentation related to digital transformation in the realm of education in the Republic of Indonesia, with a special emphasis on the 3T (Disadvantaged, Outermost, Frontier) regions. The research focus is concentrated on the implementation of education digitalization in the 3T region, taking Papua province as a referential model in this study. This research also uses the triangulation method to obtain more comprehensive data. Triangulation is done by combining various data collection methods such as literature studies to ensure the validity and reliability of the data obtained (Sugiyono, 2017). Referring to references from various reading books and related previous research findings is useful for providing a framework for the research.

RESULTS AND DISCUSSION OF FINDINGS

Data shows an increase in the use of technology by Indonesian students. According to the Central Statistics Agency (BPS) report, in 2023, around 59.33% of students aged 5-24 years used the internet for learning activities, an increase of 33.98 percent from 2016. Internet usage at the elementary school level reached 35.97 percent, junior high school 73.4 percent, high school 91.01 percent, and higher education 95.3 percent. Meanwhile, in 3T areas such as Papua there is still a significant gap in internet penetration, with mountainous areas of Papua being the lowest for internet usage at 42.57%, compared to urban areas such as Southwest Papua showing high internet penetration at 74.27% (Leo Dwi Jatmiko, 2023). The data shows that there is still a large gap in accessibility and technology infrastructure, especially in remote and underdeveloped areas such as Papua. This is exacerbated by teacher shortages and lack of internet access·

Table. 1 technology infrastructure



Research shows that technology can improve learning outcomes in various ways, such as enabling distance learning, providing access to wider resources, and enabling personalized learning (Røe et al., 2022). Technology is also proven to increase student participation, encourage them to participate, and improve their understanding of the material (Utami & Utami, 2020). However, the implementation to integrate technology in the Papua region requires more effort because, Papua has a geographical condition of mountains and rocks money is a factor inhibiting equitable distribution of education, which is then exacerbated by other factors such as, unskilled human resources and social conditions of the community, this makes the quality of education in Papua low. So, to maximize the benefits of technology in education in Papua and other remote areas, Further efforts are needed to improve infrastructure, provide training to upskill resources, and ensure that everyone in Indonesia has equal access to technology (Ssenyonga, 2021).

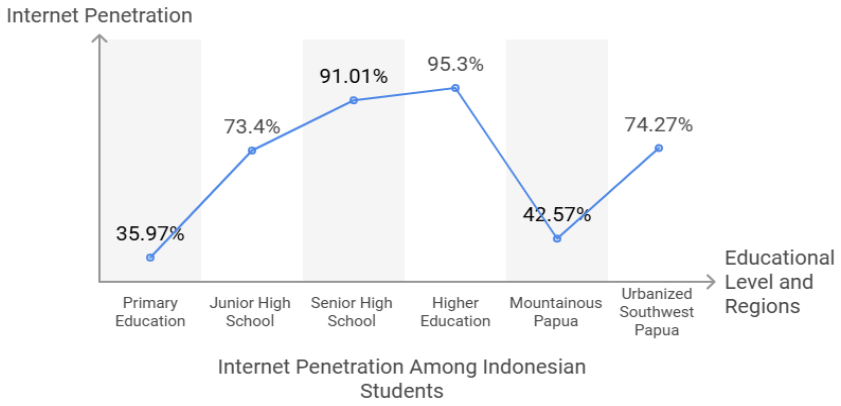
Several educational management approaches can be used to improve the quality of education in the digital era (Haleem et al., 2022a). These strategies include the application of technology in the learning process, the management of human resources in the digital era, the creation of a technology-appropriate curriculum, and the application of learning models that integrate technology (Solissa, 2023). So in this study, to achieve equitable digitization of education throughout Indonesia, especially in 3T areas such as Papua, efforts are needed to improve infrastructure, provide human resource competency training, and establish policies that ensure everyone has equal access to technology (Ralph Adolf, 2023).

An analysis of trends in the use of information and communication technology (ICT) among Indonesian students shows a significant trajectory. Based on statistical

documentation released by the Central Bureau of Statistics (BPS) in 2023, it was identified that 59.33% of the student population aged 5-24 optimized internet technology as a learning instrument, indicating a substantial increase of 33.98% when compared to 2016 data (Badan Pusat Statistik, 2023). The differentiation of internet penetration levels based on educational strata shows a progressive gradient: at the primary education level, penetration is recorded at 35.97%, experiencing significant escalation at the junior high school level with a percentage of 73.4%, then reaching higher saturation at the senior high school level with 91.01%, and reaching a culmination at the higher education level with a penetration of 95.3%.

However, disparities in digital accessibility are still observed in a distinctive manner, especially in the Least Developed, Frontier, and Disadvantaged (3T) regions. The Papua region, as a representation of the 3T regions, exhibits a substantial digital divide. Specific to the mountainous region of Papua, internet penetration is calculated at a level of 42.57%, demonstrating a significant discrepancy when compared to urbanized areas such as Southwest Papua which reaches a penetration of 74.27% (Leo Dwi Jatmiko, 2023). This phenomenon indicates the urgency of implementing a digital infrastructure equalization policy to mitigate the information technology accessibility gap between regions.

Table. 2 Analysis of trends in the use of information and communication technology



Based on the analysis of empirical data, a substantial progressive trend in the adoption and implementation of learning technologies among Indonesian learners was identified. However, significant disparities are still observed in the context of accessibility and availability of technology infrastructure, especially in peripheral areas and underdeveloped zones such as Papua Province. While the population of learners in urban areas has reached an optimal level of utilization of educational technology, contradictory conditions are found in the learning community in remote areas of Papua, where they still face multiple constraints, including limited internet

connectivity and a deficiency of human resources with adequate technological competencies. This digital divide phenomenon indicates the urgency to implement strategic interventions to mitigate discrepancies in access and utilization of learning technology between regions.

The digital transformation paradigm in the context of contemporary education management presents a multidimensional discourse that includes various fundamental aspects, especially in the context of 3T areas such as Papua. A comprehensive analysis of this phenomenon articulates several crucial elements: first, the systematic integration of information and communication technology that has implications for increasing accessibility, optimizing efficiency, and elevating learning outcomes in a diverse educational spectrum; second, the identification of implementative problems that include infrastructural disparities, limited digital connectivity, and a deficiency of technologically competent human resources; third, the elaboration of strategic initiatives that have been implemented, including government-initiated educational institution digitization programs, telecommunications infrastructure development, and multi-stakeholder collaboration in supporting technology-based learning. Furthermore, this study explores policy implications and strategic recommendations for accelerating digital transformation in marginalized areas, with the ultimate goal of providing a holistic perspective on strategies for equalizing access to education in the era of digital disruption.

The Concept of Digital Revolution and How ICT is Transforming Education.

The digital revolution has profoundly changed the global landscape, including the education sector (de las Mercedes de Obesso et al., 2023; Mohamed Hashim et al., 2022). The concept of digital revolution encompasses rapid and widespread transformations in information and communication technology (ICT), which affect the way we work, communicate and learn. Education as the foundation of societal development has undergone significant transformation due to ICT integration (Kulsum & Muhid, 2022; Agboola & Tunay, 2023). ICT has expanded the accessibility of education globally. Online platforms and digital learning resources have removed geographical and financial barriers allowing students from diverse backgrounds to access quality education at a lower cost or even for free. This brings equal learning opportunities to everyone, not just those who live in urban areas or are financially well-off (Sherman & Schafft, 2022).

In addition, ICT has changed the way teaching and learning takes place in the classroom (Haug & Mork, 2021). Educators can now utilize digital tools such as multimedia presentations, interactive simulations, and collaborative platforms to create more engaging and interacting learning experiences (Haleem et al., 2022b). This not only increases student engagement but also allows for a more personalized and

tailored approach to learning (Eirlangga et al., 2024). The digital revolution has also extended the reach of lifelong education with online courses, webinars and other self-learning resources, individuals can continue to learn and develop their skills throughout their careers (Yustitia et al., 2024). This transforms education from the traditional linear model to a more flexible and adaptive model that meets the demands of a rapidly changing world of work (Strielkowski et al., 2024).

With all the advantages that ICT offers in education, there are also challenges that must be faced (Ferri et al., 2020). One of them is the digital divide, where not everyone has equal access to the necessary technology (Saeed & Masters, 2021). This reinforces the need for efforts to ensure that all individuals especially in less developed areas, have equal opportunities to access digital education (Kaliongga et al., 2023). The digital revolution and ICT integration have fundamentally changed the education paradigm (Alenezi et al., 2023). From more inclusive learning experiences to the ability for lifelong learning, ICT is bringing positive and transformative changes to education (Wyman et al., 2023). The challenge now is to ensure that its benefits can be equally enjoyed by everyone without leaving anyone behind in this digital age.

Educational Tools and Technology (Technology-based school administration and e-learning platforms)

Educational tools and technologies including technology-based school administration and e-learning (Huang et al., 2024; Adarkwah et al., 2024) platforms have become key pillars in the modernization of the global education system. Technology-based school administration utilizes this includes student management systems that allow administration to track student data, schedules, and academic achievements in a more structured and easily accessible manner. With the integration of technology processes such as student registration, schedule setting, and reporting of school activities can be done more quickly and precisely, saving time as well as resources (Fitriyah & Santosa, 2020). On the other hand, e-learning platforms have revolutionized the way learning is done inside and outside the classroom. E-learning allows students to access learning materials flexibly from anywhere and anytime as long as they are connected to the internet. This not only increases accessibility to education for students who are in remote areas or with mobility limitations but also expands the reach of teaching by providing globally accessible content (Waruwu et al., 2022).

Another advantage of e-learning platforms is being able to offer a wide variety of learning materials ranging from texts, videos, simulations, to interactive quizzes. With this variety teachers can customize their teaching methods according to students' learning styles and provide a more engaging and immersive learning experience. In addition, the collaboration feature in e-learning platforms allows students to interact online, work together on projects, and discuss ideas, creating a dynamic and collaborative learning environment (Nuh, 2023).

Nevertheless, the implementation of educational tools and technologies does not come without challenges. One of the challenges is the digital divide where some students may not have adequate access to hardware or stable internet, this highlights the need for efforts to ensure that all students can access educational technology without barriers. In addition, the use of educational technology also raises questions about student data security and privacy that require strict policies and careful management on the part of schools and platform providers (Siagian & Wibowo, 2021).

Education both in the form of technology-based school administration and e-learning platforms have brought revolutionary changes in global education by optimally utilizing the potential of this technology and overcoming the challenges that arise education can continue to transform to prepare future generations to face the demands of an increasingly complex and digitally connected world (Jin et al., 2024).

The use of technology in learning in the 3T areas: Condition of Education in the 3T Areas

3T (Remote, Disadvantaged, Outermost) is a term used in the context of development in Indonesia (Prasya, 2024). There are several distinctive characteristics in 3T areas that distinguish them from other areas in Indonesia, such as access to education, basic infrastructure, health services and employment (Prasya, 2024). This condition makes it difficult for people to fulfill their basic needs and keep up with existing developments. Based on the list of 3T regions in Indonesia according to Presidential Regulation No.63 of 2020 concerning the implementation of underdeveloped regions 2020-2024, it is dominated by the eastern region in the provinces of Papua and West Papua with a total of 30 districts listed as underdeveloped regions (Firman, 2020).

There are 3 factors that cause Papua to be categorized as a 3T area, namely human resources, regional financial capacity, and accessibility and community characteristics. The distribution of development that has not been optimal has caused massive community accessibility to their needs (Faruqi Tutukansa & Dwi Tuffahati, 2022). As a result of this condition, community opportunities for access to educational needs are difficult to achieve as a whole for all people in Papua. Citing data (Sucahyo, 2023), more than 620 thousand children at the elementary, junior high, high school / vocational school levels are not in school or do not complete their education, according to University of Papua education expert Dr. Agus Irianto Sumule that the general problem experienced is the lack of teaching human resources in Papua. This condition is also supported by limited digitization and technology in education, the lack of integration of educational technology causes *updates* to material sources or teaching materials to be lacking so that conventional teaching and learning is still the main method in education (Sulistiawati & Prastowo, 2021).

Government Regulations and Programs Supporting the Use of Technology in Learning in 3T Areas.

The implementation of digitization-based education is considered quite difficult to do. In urban areas, the implementation of education digitization is still possible because stable education infrastructure and internet access support the integration of technology in learning, however, it is different with other remote areas. The topography of the interior in Papua makes it difficult to reach access to education (I Gusti Ayu Ngurah Kade Sukiastini, 2020). In addition, the level of security in Papua is an obstacle to education because (Kogoya et al., 2023), some volunteer educators who have been sent on duty orders by the government are hampered by security factors (Shainna, 2023), especially in conflict-prone areas such as in Nduga, Boven Digoel and others.

The education gap experienced by the 3T areas, especially Papua, has made the government finally take policy and program steps so that education can also be felt by people in the 3T areas. some of the policies taken by the government are as follows:

1. Information and Communication Technology Master Plan (Renduk TIK): The Renduk TIK has been established by the Papua provincial government as a guideline for OPDs (regional device organizations) for the development of information and communication technology. The Renduk TIK contains a strategic plan for ICT development that is in line with the Papua provincial government's plan. Improving efficiency and effectiveness in various sectors including education is the main goal of implementing Renduk TIK.
2. Infrastructure Development Policy: in an effort to encourage equitable digitalization of education, the central government in 2018 sought to improve internet access in Papua by building high-speed internet in 41 districts, including 31 newly built districts with the aim of providing easy accessibility to education. This effort continues to this day to meet the equitable digitalization of education in 3T areas (Web Manager, 2019).
3. School Digitalization Program: The Ministry of Education and Culture has launched a school digitization program to improve quality and access in 3T areas. The program provides technology devices such as computers, tablets, laptops and internet access to schools in remote areas such as Papua (Web, 2019).

The policies and programs initiated by the government are expected to encourage the growth of the quality of education in 3T areas, especially Papua. The existence of technology today cannot be separated from various activities, one of which is education. To optimize learning, it is not enough to use conventional learning methods, technology integration is needed in order to access a wider range of knowledge materials. We all know that education is the foundation for building a more decent life and bringing hope to improve living standards.

Effective Education Management Strategies Using Technology In 3T Areas

Improving the quality of a country's human resources relies heavily on education. However, in Indonesia, especially in the 3T (Frontier, Outermost and Disadvantaged) areas, there are still significant gaps in access to high-quality education. These areas often face problems such as limited infrastructure, lack of competent teaching staff, and limited access to technology and educational resources. Papua as an area categorized as a 3T region has all these problems ranging from uneven development of educational infrastructure, low quality of teaching staff and difficult accessibility to learning resources.

Utilizing technology in education management is very important in the current information era. Thus, technology can be used as a tool for education management and improving access, quality and efficiency of the learning process in the 3T areas (Maulido et al., 2024). However, in order to maximize the impact of technology in education management in the 3T areas, a strategy is required that appropriate and tailored to the local context. Hence, some strategies that can be implemented in the 3T areas:

1. *Capacity Building* for Teachers and Education Personnel: Capacity building, also known as training and capacity building, is an essential component of effective education management strategies using technology in 3T areas. By equipping teachers and education personnel with the necessary skills and knowledge, they can maximize the use of technology in management and learning processes. This training can take the form of digital literacy with skills to use technological devices and digital communication platforms (Badari, 2022).
2. Utilization of Technology for School Management (Burhan et al., 2023): To improve the effectiveness and efficiency of education management, especially in the 3T (Frontier, Outermost and Disadvantaged) areas, the use of technology is an important strategy. Various tasks in schools can be completed more quickly, accurately and organized by using technology.
3. Building Collaborations and Partnerships with Government, Non-Profit Organizations, and Private Sector: As the challenges faced in 3T (Frontier, Outermost, and *Disadvantaged*) areas are often complex and require support and resources from various parties, collaboration and partnerships with various parties are essential in the effort to utilize technology to support learning.

CONCLUSIONS

Digital transformation in the context of education management has shown substantial significance in optimizing accessibility, operational effectiveness, and the quality of the learning process, particularly through the implementation of e-learning systems and the digitization of education institution administration. However,

empirical studies indicate extensive technological disparities in the 3T (frontier, outermost, underdeveloped) regions, with a specific focus on the Papua region. Complex topographical conditions, limited information and communication technology (ICT) infrastructure and a deficiency of digitally competent human resources are the main determinants that hinder equitable access to education technology. To overcome these problems, an integrated multi-stakeholder collaborative approach is needed, including the government, educational institutions, the private sector, and the community, accompanied by a structured and sustainable capacity building program to accelerate digital transformation in the education sector.

This study contributes significantly to the theoretical and practical development of digital-based education management, particularly in Indonesia's 3T regions. By considering Indonesia's complex geography and socio-cultural diversity, the research identifies key factors for optimizing educational technology, such as educator competency development, digital infrastructure, and multisectoral collaboration. The conceptual framework developed can guide strategic policies to reduce the digital divide and create a more equitable education system. The study's recommendations focus on sustainable capacity building for educators, accelerated ICT infrastructure development, and stronger collaboration among stakeholders to ensure equitable access to quality education across Indonesia.

This research has several limitations, including its reliance on secondary data from literature reviews without primary data from field observations or interviews. As a result, the study cannot fully address the contemporary socio-cultural dynamics of the Papua region, lacking direct engagement with the indigenous context. The recommendations made are general and have not been empirically tested, so their applicability and effectiveness in Papua's specific context remain uncertain. Additionally, the study does not account for variations in cases, locations, gender, age, or other demographic factors, which could influence the outcomes and strategies discussed.

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