

A Transformational Leadership Model for School Principals in Accelerating the Digital Transformation of Vocational High School Management Toward SDG 4

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DOI : <https://doi.org/10.63230/jocsis.3.1.238>

Sections Info

Article history:

Submitted: February 8, 2026

Final Revised: May 5, 2026

Accepted: June 19, 2026

First Available Online: July 17, 2026

Publication Date: March 27, 2027

Keywords:

Digital Transformation;

Educational Leadership;

Management;

Technology-Based School;

Transformasional Leadership;

Vocational Education.

ABSTRACT

Objective: To analyze the role of transformational leadership in accelerating the digital transformation of technology-based school management in vocational high schools and to explore leadership strategies employed by school principals in supporting sustainable digital innovation. **Method:** A qualitative approach with a multi-case study design was employed at Mitra Sehat Mandiri Vocational High School Sidoarjo and Vocational High School 1 Sidoarjo. Data were collected through in-depth interviews, observations, and document analysis involving principals, vice principals, teachers, administrative staff, and school operators. The data were analyzed using the interactive model of Miles, Huberman, and Saldaña, while credibility was ensured through triangulation, member checking, and prolonged engagement. **Result:** The findings indicate that both schools have successfully integrated digital technologies into learning, administration, communication, and decision-making processes. Transformational leadership emerged as a key factor in establishing a digital vision, identifying the potential of educators and educational staff, facilitating professional development, and supporting organizational adaptation to technological change. Continuous principal support through infrastructure provision, training, mentoring, and evaluation significantly improved digital readiness and institutional effectiveness. Furthermore, the study identified two complementary pathways of digital transformation, namely system-driven and culture-driven approaches, which collectively contribute to sustainable organizational change. **Novelty:** To develop of a conceptual model of technology-based school management transformation that integrates transformational leadership, organizational culture, human resource readiness, and technological infrastructure as toward SDGs 4. The findings suggest that sustainable digital innovation in vocational education requires a balanced integration of system-oriented and culture-oriented transformation strategies.

INTRODUCTION

The rapid development of Information and Communication Technology (ICT) has transformed various sectors, including education. Educational institutions are increasingly required to adapt to digital transformation by integrating technology into learning processes, administrative management, and organizational governance. Technology-based education enables schools to improve learning accessibility, personalize educational experiences, and enhance operational efficiency (Moscato & Embre, 2023; Japar et al., 2024; Sobari, 2024). The implementation of digital platforms, learning management systems, and school information systems has become an essential component in supporting educational quality improvement in the digital era.

Technology integration has significantly influenced school management practices. Digital-based school management facilitates efficient administration, improves data accuracy, and supports evidence-based decision-making. Previous studies have demonstrated that digitalization can reduce administrative errors, improve service quality, and enhance institutional effectiveness (Akbar & Noviani, 2019; Yanti et al., 2024). In the learning context, technology supports online learning, blended learning, and interactive pedagogical approaches that increase student engagement and learning

flexibility (Wahyu & Jatun, 2024; Ramadanti et al., 2024; Samad & Abbas, 2024). Despite these advantages, many educational institutions still encounter substantial challenges in maximizing technology utilization, particularly regarding infrastructure limitations, inadequate digital competencies, and insufficient financial resources (Andriyan & Yoenanto, 2022; Irshadi & Ivaanna, 2024).

In Indonesia, educational digitalization has become a strategic national priority. The ministry of education, culture, research, and technology has distributed more than 1.3 million ICT devices to over 79,000 schools and promoted various digital platforms, including Merdeka Mengajar, SIPLah, and ARKAS, to strengthen educational transformation (Kemendikbudristek, 2024). Furthermore, the implementation of the Merdeka Curriculum has expanded to hundreds of thousands of schools, including institutions located in disadvantaged regions (Indonesia.go.id, 2022). These initiatives reflect the government's commitment to creating an inclusive and technology-oriented education system. However, disparities in infrastructure availability and digital readiness remain significant barriers, particularly among schools with limited access to technological resources (Putro et al., 2023).

The successful implementation of technology-based school management depends not only on technological infrastructure but also on leadership capacity. School principals play a central role in formulating strategic visions, managing organizational change, and fostering innovation within educational institutions. In the context of digital transformation, principals are expected to facilitate the development of teachers' digital competencies, encourage collaboration, and create organizational cultures that support innovation (Wiyana et al., 2024). Nevertheless, empirical evidence indicates that many school leaders still face challenges in effectively managing digital transformation due to limited technological expertise, resistance to change, and resource constraints (Hafizah et al., 2024; Indriana, 2024).

Transformational leadership has emerged as one of the most relevant leadership approaches for addressing these challenges. Transformational leaders inspire organizational members, promote innovation, stimulate intellectual growth, and encourage collective commitment toward organizational goals (Purwanti & Hartati, 2024; Rifdan et al., 2024). In educational settings, transformational leadership has been associated with successful digital transformation, teacher empowerment, and organizational adaptability (Sugiyuwanta, 2024; Jayadih et al., 2024; Rohmaniah & Pudjiarti, 2024). Furthermore, transformational school leaders are better positioned to address resistance to technological change and establish supportive environments for continuous professional development (Elmanisar et al., 2024).

Despite the growing body of literature on educational technology and digital transformation, several research gaps remain evident. Previous studies have primarily focused on the technical implementation of educational technologies, such as Learning Management Systems (LMS), e-learning platforms, and digital administration systems (Maisura et al., 2023; Sarnoto et al., 2023; Firman, 2024; Putri et al., 2024). Although these studies confirm the benefits of technology adoption, they provide limited insights into the leadership processes that facilitate successful implementation. Conversely, studies examining transformational leadership in educational organizations have generally focused on leadership effectiveness without specifically investigating technology-based school management contexts (Goreta et al., 2022; Mardizal & Jalinus, 2023; Nasir et al., 2023). Consequently, limited empirical evidence exists regarding how transformational leadership strategies support digital innovation and technology-based management in vocational secondary schools.

This research addresses these gaps by examining the role of transformational leadership in managing technology-based schools within vocational education settings. Vocational schools possess unique characteristics due to their strong orientation toward workforce readiness, industry collaboration, and practical skill development. Therefore, understanding how school principals lead digital transformation in vocational education is critical for improving educational quality and institutional competitiveness. The study focuses on Mitra Sehat Mandiri vocational high school Sidoarjo and Vocational High School 1 Sidoarjo, two Vocational High Schools that have actively implemented technology-based management systems and digital learning innovations.

The novelty of this study lies in its integration of transformational leadership theory with technology-based school management practices within the vocational education context. Unlike previous studies that examine leadership or technology adoption separately, this study investigates how transformational leadership strategies facilitate digital innovation, support teachers and educational staff, and drive organizational change in vocational schools. The findings are expected to contribute to the development of a comprehensive understanding of educational leadership in the digital era and provide practical implications for policymakers and school administrators.

Therefore, this study aims to analyze the role of transformational leadership in managing technology-based schools and to explore strategies employed by school principals to support digital transformation in vocational education institutions. Specifically, the study seeks to: (1) identify the profile of technology-based school management; (2) examine how principals identify the potential of teachers and educational staff in supporting technology-based management; (3) analyze leadership support provided to teachers and educational staff; and (4) investigate transformational leadership strategies employed to manage organizational change toward technology-based school management.

RESEARCH METHOD

This study was conducted to gain an in-depth understanding of the role of transformational leadership in technology-based school management at Vocational High Schools. The rapid advancement of digital transformation in education requires school principals not only to function as administrators but also as change agents who can effectively integrate technology into school management and learning processes. Transformational leadership is considered a critical factor in fostering an innovative organizational culture, enhancing human resource capabilities, and facilitating sustainable organizational change toward effective technology-based educational management (Bass & Avolio, 1993; Fullan, 2007). Therefore, this research employed a qualitative approach with a multi-case study design to explore and compare the implementation of transformational leadership in technology-based school management at Mitra Sehat Mandiri Vocational High School Sidoarjo and Vocational High School 1 Sidoarjo.

A qualitative approach was selected because it enables researchers to explore and understand participants' experiences, perceptions, and interpretations of social phenomena within their natural settings. According to Creswell and Poth (2018), qualitative research seeks to understand the meanings individuals or groups assign to a particular social or human problem. Furthermore, a multi-case study design was adopted because the research involved two Vocational High Schools that have implemented technology-based management systems while operating within different

organizational contexts. This design allows for cross-case analysis to identify similarities, differences, and emerging patterns regarding transformational leadership practices in managing technology-based schools.

The participants of this study consisted of school principals, vice principals, teachers, administrative staff, school operators, and other stakeholders directly involved in the implementation of technology-based school management. Participants were selected using purposive sampling based on their experience, knowledge, and level of involvement in the phenomenon under investigation (Patton, 2015). The study utilized both primary and secondary data sources. Primary data were collected through in-depth interviews and direct observations, while secondary data were obtained from school documents, digital transformation reports, institutional records, and other relevant supporting documents.

The researcher served as the primary research instrument, which is a fundamental characteristic of qualitative inquiry (Sugiyono, 2023). To support the data collection process, semi-structured interview guides, observation protocols, and documentation checklists were employed. The research procedure began with a preliminary stage involving site selection, instrument preparation, and administrative permissions. Data collection was subsequently conducted through in-depth interviews, participant observation, and document analysis. To ensure the trustworthiness of the findings, data credibility was established through source triangulation, method triangulation, member checking, and prolonged engagement in the field (Lincoln & Guba, 1985).

Data analysis was carried out simultaneously with the data collection process using the interactive analysis model proposed by Miles, Huberman, and Saldaña (2014), which consists of data condensation, data display, and conclusion drawing/verification. During the data condensation stage, the collected information was selected, simplified, categorized, and organized according to the research focus. The data were then presented in the form of narrative descriptions, matrices, and thematic displays to facilitate interpretation. Finally, conclusions were drawn and continuously verified through repeated examination of the collected data until consistent themes and patterns emerged. Through these systematic procedures, the study is expected to generate valid, reliable, and comprehensive findings that contribute both theoretically and practically to the development of technology-based educational management in Indonesia.

RESULTS AND DISCUSSION

Results

Profile of technology-based school management at Mitra Sehat Mandiri Vocational High School Sidoarjo and Vocational High School 1 Sidoarjo

The findings revealed that both schools have implemented technology-based school management as part of their educational transformation strategy. Technology has been integrated into learning activities, administrative services, data management, communication systems, and school decision-making processes. However, the two schools demonstrated different approaches in managing technological transformation. Mitra Sehat Mandiri Vocational High School Sidoarjo adopted a gradual and adaptive approach by utilizing the Google Workspace ecosystem as the primary platform for learning and administration. As stated by the principal, "We utilize Google Classroom, Google Meet, Google Drive, Google Sheets, Forms, and Docs as integrated platforms for both learning and administrative activities." The school has also provided supporting facilities such as Wi-Fi access, computers, projectors, and vocational laboratories to

support digital learning. Technology is utilized in classroom instruction through online assignments, digital assessments, learning videos, and project-based activities, while administrative services are conducted through digital data management systems and electronic financial transactions.

In contrast, Vocational High School 1 Sidoarjo has implemented a more systematic and structured technology management model through a digital roadmap integrated into its strategic planning. The principal explained that technology implementation was developed through a long-term plan involving digital management systems, Learning Management Systems (LMS), Computer-Based Testing (CBT), and digital administration. The school has established various digital infrastructures, including academic information systems, LMS platforms, digital attendance systems, cloud storage, and technology-supported vocational laboratories. The findings also indicated that technology contributes positively to learning flexibility, administrative efficiency, data transparency, and students' digital competencies in both schools. Nevertheless, several challenges remain, including internet connectivity issues, unequal access to digital devices among students, varying levels of teachers' digital literacy, and the need for continuous maintenance of technological infrastructure. Overall, the results indicate that both schools have successfully integrated technology into school management, although Vocational High School 1 Sidoarjo demonstrates a higher level of system integration and digital governance maturity compared to Mitra Sehat Mandiri Vocational High School Sidoarjo.

Identification of the potential of educators and educational staff in supporting technology-based school management

The findings revealed that both Mitra Sehat Mandiri Vocational High School Sidoarjo and Vocational High School 1 Sidoarjo have implemented systematic approaches to identifying the technological potential of educators and educational staff. At vocational high school Mitra Sehat Mandiri Sidoarjo, the identification process was conducted through the analysis of curriculum vitae, professional certifications, training records, periodic competency assessments, and performance evaluations related to technology use in teaching and administrative activities. Meanwhile, Vocational High School 1 Sidoarjo employed a more integrated approach by assessing educators' ability to use Learning Management Systems (LMS), participation in digitalization programs, involvement in technology training, and direct observations of teaching and administrative practices. In both schools, digital literacy, technology utilization skills, creativity in applying digital tools, and adaptability to technological changes were identified as the primary indicators for evaluating staff potential.

The results further showed that the identified competencies were utilized to support school management through competency mapping, task allocation, training planning, mentoring programs, and the establishment of digital development teams. Educators with advanced technological skills were assigned as mentors to support colleagues with lower levels of digital competence. Both schools implemented various professional development activities, including workshops, internal and external training programs, IT assistance, and self-directed learning initiatives. However, several challenges were identified, including disparities in digital competence among staff, limited time for professional development, resistance to technological change, and the rapid evolution of digital technologies. Despite these challenges, educators, administrative staff, and technical personnel demonstrated active involvement in supporting technology-based

school management, contributing to the development of a collaborative and sustainable digital learning environment.

Principal support for educators and educational staff in technology-based school management

The results of this multi-case study revealed that school principals play a crucial role in supporting educators and educational staff in the implementation of technology-based school management. In both Mitra Sehat Mandiri Vocational High School Sidoarjo and Vocational High School 1 Sidoarjo, principal support extended beyond the provision of technological facilities and included strategic policies, professional development programs, technical assistance, motivation, and continuous evaluation. At Mitra Sehat Mandiri Vocational High School Sidoarjo, support was provided through the availability of Wi-Fi, laptops, projectors, and the implementation of Google Workspace as the primary digital platform. The principal also facilitated regular workshops and training programs related to digital learning, electronic administration, and technology maintenance, while promoting innovation through direct guidance and constructive supervision. Meanwhile, at Vocational High School 1 Sidoarjo, support was implemented through a more structured system involving the use of a Learning Management System (LMS), digital administrative services, and an internal IT team that assisted teachers and staff in addressing technical challenges. These efforts demonstrate the principals' commitment to creating a supportive environment that encourages the effective use of technology in both instructional and administrative activities.

Furthermore, the findings showed that principal support positively influenced the digital competence, confidence, and performance of educators and educational staff. Motivation was fostered through leadership by example, persuasive communication, recognition of innovative practices, and opportunities for continuous professional learning. Evaluation processes were conducted regularly through monitoring technology utilization, supervision activities, internal feedback, and performance reviews to ensure the effectiveness of digital implementation. Although both schools shared similar goals in strengthening technology integration, differences were identified in their approaches. Mitra Sehat Mandiri Vocational High School Sidoarjo adopted a more flexible and gradual strategy that reflected its institutional context and available resources, whereas Vocational High School 1 Sidoarjo implemented a more systematic and comprehensive model supported by dedicated technological infrastructure and structured digital management systems. Overall, the findings indicate that sustained principal support contributes significantly to improving digital readiness, enhancing professional performance, and strengthening technology-based school management practices.

Transformational leadership strategies in managing technology-based change

The findings revealed that the principals of both schools played a central role in leading technology-based transformation through strategic planning, policy development, capacity building, and continuous evaluation. At Mitra Sehat Mandiri Vocational High School Sidoarjo, the transformation process began with the establishment of a digital foundation using the Google Workspace ecosystem as the main platform for learning, administration, and school management. The principal developed a digitalization strategic plan and implemented technology integration gradually through infrastructure development, policy implementation, and system integration. The school provided internet access, digital learning devices, and administrative applications while

encouraging teachers and staff to transition from manual to digital work systems. Regular training programs, technical assistance, and periodic troubleshooting were conducted to support implementation. Evaluation was carried out through feedback from teachers and students as well as indicators such as administrative efficiency, data accessibility, and the effectiveness of learning processes. Despite these efforts, several challenges were identified, including unstable internet connectivity, limited maintenance budgets, shortages of technical personnel, unequal digital competencies among teachers, and varying levels of students' access to digital devices.

In contrast, Vocational High School 1 Sidoarjo adopted a transformation strategy that emphasized cultural change before technological implementation. The principal first established a shared vision of digital transformation among school stakeholders and subsequently developed a digital roadmap covering learning, administration, and institutional management. The implementation process was supported by formal policies regarding the use of Learning Management Systems (LMS), Computer-Based Testing (CBT), and digital administrative systems. An internal IT team was established to support implementation, while continuous training, mentoring, monitoring, and system evaluations were conducted to ensure sustainability. Technology integration was applied throughout instructional planning, learning activities, assessment, supervision, and administrative services. Teachers, administrative staff, and technical personnel reported significant improvements in work efficiency, transparency, communication, and learning quality. However, the school also encountered challenges related to differences in digital literacy, resistance to change, infrastructure limitations, budget constraints, and network stability. Overall, the results indicate that both principals successfully implemented transformational leadership strategies by promoting digital innovation, strengthening organizational capacity, facilitating stakeholder adaptation, and ensuring the continuous development of technology-based school management systems.

Discussion

Profile of technology-based school management at Mitra Sehat Mandiri Vocational High School Sidoarjo and Vocational High School 1 Sidoarjo.

The findings indicate that technology-based school management at Mitra Sehat Mandiri Vocational High School Sidoarjo and Vocational High School 1 Sidoarjo reflects an ongoing digital transformation that extends beyond technology adoption toward organizational change. This finding supports Petko et al. (2025), who argued that successful digital transformation involves the integration of leadership, organizational culture, management structures, and pedagogical practices within a comprehensive digital ecosystem. Both schools have integrated technology into learning, administration, communication, and data management processes, demonstrating that digitalization has become an essential component of educational governance. However, the differences in implementation approaches confirm that digital transformation is highly contextual and influenced by organizational readiness, leadership capacity, and available resources, as emphasized by Mohammed et al. (2026), Sopiulloh et al. (2026), and Gadzhimusieva et al. (2026).

The adaptive model implemented by Mitra Sehat Mandiri Vocational High School Sidoarjo aligns with the findings of Rojas-Briñeza et al. (2023), who highlighted that schools with limited resources often adopt incremental digital transformation strategies. The school's reliance on Google Workspace as an integrated platform demonstrates a practical approach that prioritizes accessibility, usability, and gradual adaptation. Such

an approach enables teachers and staff to develop digital competencies progressively while minimizing resistance to change. In contrast, Vocational High School 1 Sidoarjo exhibits a more advanced level of digital maturity through the integration of Learning Management Systems (LMS), Computer-Based Testing (CBT), academic information systems, and digital administration. This finding supports Schmitz et al. (2023), who reported that transformational leadership contributes significantly to higher levels of technological integration, innovation, and data-driven decision-making. The existence of a digital roadmap and structured implementation procedures in Vocational High School 1 Sidoarjo further demonstrates how strategic leadership can accelerate institutional digital transformation.

The differences in infrastructure readiness between the two schools also reinforce the argument of Reis-Andersson (2024), who stated that infrastructure is a critical prerequisite for digital transformation but does not solely determine success. While Vocational High School 1 Sidoarjo benefits from more comprehensive technological infrastructure, Mitra Sehat Mandiri Vocational High School Sidoarjo successfully maximizes available resources through a pragmatic and needs-based approach. This suggests that effective digital transformation depends not only on technological sophistication but also on how technology is strategically aligned with institutional goals. Furthermore, the integration of digital tools into teaching and learning processes in both schools supports the findings of Peng et al. (2024), who emphasized that educational technology enhances student engagement, learning flexibility, and access to learning resources when combined with effective pedagogical strategies and adequate institutional support.

The study also demonstrates that digital administration has become a key indicator of technological maturity in educational institutions. The findings are consistent with Li et al. (2023), who argued that digital administration improves efficiency, transparency, accountability, and evidence-based decision-making. Both schools have adopted digital systems for managing student data, financial administration, and institutional records, although at different levels of complexity. This finding is further supported by Kabkus et al. (2025), who emphasized that the effectiveness of digital governance largely depends on the digital literacy and readiness of human resources. Consequently, digital transformation should be viewed not merely as technological implementation but as the development of organizational capacity to manage and utilize information effectively.

Despite the positive outcomes, both schools continue to face challenges related to infrastructure limitations, internet connectivity, digital competency gaps, and adaptation to new systems. These findings are consistent with Abibin et al. (2025), who identified technological, organizational, and psychological barriers as common obstacles in educational digitalization. Similarly, Maxwell (2024) highlighted the importance of capacity-building programs, including continuous training, mentoring, and institutional support, to overcome these barriers. The results suggest that sustainable digital transformation requires ongoing investment in human resource development alongside technological improvement. Therefore, strengthening digital literacy among teachers, administrative staff, and technical personnel should remain a strategic priority.

Another important finding concerns the role of organizational culture in facilitating technology integration. The adaptive culture observed at Mitra Sehat Mandiri Vocational High School Sidoarjo and the more established digital culture at Vocational High School 1 Sidoarjo support the conclusions of Rasdiana et al. (2024), who found that innovation-oriented organizational cultures significantly accelerate digital

transformation. Likewise, Aksal (2015) argued that digital culture develops gradually through leadership support, collaborative practices, and continuous learning. The differences observed between the two schools indicate varying levels of digital maturity, yet both institutions demonstrate positive progress toward establishing sustainable technology-based educational ecosystems.

The findings further confirm the strategic importance of transformational leadership in managing educational change. Consistent with Okunlola (2024), the principals in both schools function as digital leaders who guide vision development, encourage innovation, allocate resources, and motivate stakeholders to embrace technological change. The leadership approach at Mitra Sehat Mandiri Vocational High School Sidoarjo focuses more on motivation and gradual adaptation, whereas Vocational High School 1 Sidoarjo emphasizes strategic planning and system integration; nevertheless, both approaches reflect key characteristics of transformational leadership. This observation also supports Thomas (2025), who emphasized that effective digital leadership combines visionary thinking, innovation, collaboration, and organizational empowerment. Therefore, the success of technology-based school management is closely associated with the ability of school leaders to align technological innovation with institutional goals and stakeholder needs.

Future research should explore the long-term impact of technology-based school management on student achievement, teacher performance, organizational effectiveness, and institutional competitiveness. Comparative studies involving schools with different organizational characteristics and levels of technological readiness may also provide a broader understanding of effective digital transformation strategies in vocational education. Additionally, future studies may examine how artificial intelligence, learning analytics, and emerging digital technologies can further support educational management and leadership practices in schools.

Identification of the potential of educators and educational staff in supporting technology-based school management

The findings demonstrate that transformational leadership plays a pivotal role in managing technology-based change within vocational schools. The digital transformation initiatives implemented at Mitra Sehat Mandiri Vocational High School Sidoarjo and Vocational High School 1 Sidoarjo indicate that technology integration is not merely a technical process but a strategic organizational transformation that requires visionary leadership, cultural adaptation, and continuous capacity development. This finding supports the argument of Zai et al. (2024), who emphasized that school leaders function not only as change agents but also as meaning makers who shape how technological innovation is interpreted, accepted, and institutionalized within educational organizations. Consequently, technology-based transformation should be understood as a socio-organizational process rather than a simple technological intervention.

From a leadership perspective, the two schools demonstrate different transformational approaches in managing digital change. Mitra Sehat Mandiri Vocational High School Sidoarjo initiated transformation by strengthening its digital infrastructure and integrating Google Workspace into school operations, whereas Vocational High School 1 Sidoarjo prioritized the development of a shared vision and digital culture before implementing technological systems. This distinction reflects two complementary dimensions of transformational leadership: structural transformation and cultural transformation. Schmitz et al. (2023) argued that successful digital

transformation requires leaders to simultaneously establish technological systems and cultivate organizational commitment toward innovation. Therefore, the differences observed between the two schools should not be interpreted as competing approaches but rather as alternative pathways toward organizational digitalization.

Critically, the infrastructure-oriented strategy adopted by Mitra Sehat Mandiri Vocational High School Sidoarjo demonstrates practical advantages in accelerating technology utilization and operational efficiency. However, an excessive focus on technological systems may risk reducing digital transformation to a technical project rather than an organizational learning process. Conversely, the vision-driven strategy implemented by Vocational High School 1 Sidoarjo strengthens collective commitment and reduces resistance to change, yet it requires a longer adaptation period before tangible technological outcomes become visible. This finding reinforces Nashrullah et al. (2024), who argued that effective digital transformation requires a balance between technological systems and human agency. Digital transformation that is overly system-oriented may create dependency on technology, while transformation that focuses solely on cultural change may experience delays in implementation.

The findings also highlight the importance of strategic planning in supporting technology-based change. Both schools developed structured digital transformation plans, although with different emphases and levels of complexity. This observation supports Thomas (2025), who emphasized that transformational leaders must combine visionary thinking with strategic execution. The existence of digital roadmaps, institutional policies, implementation stages, and evaluation mechanisms in both schools indicates that transformational leadership extends beyond inspiration and motivation toward the systematic management of organizational change. Consequently, leadership effectiveness should be assessed not only through vision articulation but also through the ability to translate vision into sustainable organizational practices.

Another significant finding concerns the role of capacity building as a central strategy in digital transformation. Both schools implemented continuous training, mentoring, and technical support programs to improve digital competencies among teachers and staff. This finding aligns with Maxwell (2024), who identified professional development and organizational learning as critical factors in overcoming digital transformation barriers. However, a critical perspective suggests that training programs alone may not guarantee meaningful competence development. Abdullah et al. (2024) argued that sustainable digital competence emerges through reflective practice, collaborative learning, and authentic engagement with technological challenges rather than through procedural training alone. Therefore, future leadership strategies should integrate formal training with professional learning communities and peer-support mechanisms.

The challenges encountered by both schools further demonstrate that digital transformation remains a multidimensional process involving technological, organizational, and human factors. Infrastructure limitations, digital literacy gaps, resistance to change, and technical maintenance issues reflect broader challenges identified by Abibin et al. (2025). Importantly, resistance should not be viewed solely as an obstacle but also as a form of organizational feedback regarding the readiness and relevance of transformation initiatives. Marisa and An Nur (2021) argued that resistance often signals misalignment between organizational policies and individual needs. Thus, transformational leaders must adopt participatory approaches that encourage dialogue, collaboration, and stakeholder engagement rather than relying exclusively on top-down directives.

Organizational culture emerged as another crucial determinant of successful technology-based change. Vocational High School 1 Sidoarjo developed a collaborative digital culture supported by formal policies and institutional structures, while Mitra Sehat Mandiri Vocational High School Sidoarjo fostered a more adaptive and flexible environment characterized by gradual technological adoption. These findings support Rasdiana et al. (2024), who emphasized that innovation-oriented cultures significantly accelerate digital transformation. Similarly, Aksal (2015) argued that sustainable digital culture develops through continuous interaction among leadership practices, organizational values, and collaborative learning processes. Therefore, technology implementation should not be separated from broader efforts to cultivate organizational cultures that support innovation and continuous improvement.

The study further reveals that transformational leadership functions as a mechanism for balancing structure and flexibility during organizational change. Vocational High School 1 Sidoarjo demonstrates the benefits of structured governance and formalized digital systems, while Mitra Sehat Mandiri Vocational High School Sidoarjo illustrates the value of adaptability and contextual responsiveness. This finding is consistent with Zulpikar et al. (2023), who argued that transformational leaders must balance organizational control with professional autonomy. Excessive standardization may limit creativity and innovation, whereas excessive flexibility may create inconsistencies in implementation. Consequently, successful digital transformation requires leadership strategies capable of integrating both organizational stability and adaptive capacity.

Overall, this study suggests that there is no universally applicable model of transformational leadership in technology-based school management. Rather, leadership effectiveness depends on the ability to align digital transformation strategies with institutional contexts, organizational cultures, resource availability, and stakeholder readiness. Consistent with Zai et al. (2024), transformational leaders serve as catalysts who bridge technological innovation, organizational structures, and human development. The findings therefore contribute to the growing body of literature by demonstrating that successful digital transformation in vocational education is achieved through a dynamic interaction among leadership, culture, technology, and organizational learning.

Future studies should examine how different transformational leadership approaches influence long-term educational outcomes, teacher innovation, student achievement, and institutional performance. Further research may also explore the integration of artificial intelligence, learning analytics, and emerging digital technologies as strategic tools for strengthening transformational leadership and technology-based school governance in vocational education.

Principal support for educators and educational staff in technology-based school management

The digital transformation of education has repositioned school principals from administrative managers to strategic leaders who are responsible for integrating technology into educational governance, organizational culture, and human resource development. In this context, transformational leadership becomes a crucial approach because it enables school leaders to establish a shared vision, encourage innovation, and facilitate organizational adaptation to technological change. Previous studies emphasized that the success of technology integration in schools is strongly influenced by principals' leadership capacity in managing change and fostering an inclusive digital culture (Kausar et al., 2025; Ubaedullah et al., 2025). The findings of this study indicate

that both Mitra Sehat Mandiri Vocational High School Sidoarjo and Vocational High School 1 Sidoarjo have implemented principal support as a strategic instrument for technology-based school management, although through different approaches that reflect their organizational characteristics and levels of digital maturity.

At Vocational High School Mitra Sehat Mandiri Sidoarjo, principal support is characterized by an adaptive and relationship-oriented approach. The findings show that technology implementation was initiated through the utilization of Google Workspace, supported by direct communication, continuous mentoring, and the provision of digital facilities for teachers and staff. This finding aligns with Tobondo (2025), who argued that transformational leaders often rely on interpersonal relationships and collaborative cultures to encourage technology adoption. Such an approach creates a supportive environment that motivates teachers to engage with digital tools and gradually develop digital competencies. However, while this model promotes flexibility and responsiveness, it may also create challenges regarding standardization and long-term sustainability because implementation depends heavily on individual commitment and informal coordination mechanisms.

In contrast, Vocational High School 1 Sidoarjo demonstrates a more systematic and structured form of principal support. The establishment of a digital roadmap, implementation of Learning Management Systems (LMS), Computer-Based Testing (CBT), and the formation of an internal IT team illustrate a strategic effort to institutionalize digital transformation. This finding supports Nashrullah et al. (2024), who emphasized that successful digital transformation requires integrated systems and long-term planning. The principal's role extends beyond motivation to include policy formulation, monitoring, and system evaluation. Nevertheless, an overly system-driven approach may create organizational rigidity if technological procedures become more dominant than pedagogical innovation. Therefore, balancing organizational structure with professional autonomy remains essential to ensure sustainable innovation within the school environment.

The findings further reveal that both schools prioritize human resource development as a key strategy for supporting technology-based management. At Vocational High School Mitra Sehat Mandiri, training activities are conducted flexibly according to teachers' needs and readiness, while Vocational High School 1 Sidoarjo adopts a more structured model through scheduled professional development programs and technical assistance. These findings are consistent with Elih et al. (2025), who argued that transformational leadership should integrate both adaptive and structured professional development approaches to enhance digital competencies. The results suggest that effective digital transformation is not determined solely by the frequency of training but also by the extent to which learning experiences encourage reflection, collaboration, and practical application in daily educational activities.

Differences also emerge in motivational strategies employed by the principals. At Vocational High School Mitra Sehat Mandiri, motivation is primarily fostered through personal example, direct guidance, and continuous encouragement, reflecting a humanistic leadership orientation. Conversely, Vocational High School 1 Sidoarjo combines inspirational leadership with formal recognition systems and institutional support mechanisms. This finding supports Hutagalung et al. (2025), who noted that transformational leadership is most effective when intrinsic and extrinsic motivational factors are integrated. While personal influence strengthens emotional commitment and organizational trust, formal rewards can reinforce engagement and accountability across larger and more complex educational organizations.

The impact of principal support is evident in both schools through improvements in teacher competence, administrative efficiency, and instructional quality. Teachers reported increased confidence in utilizing digital technologies, while administrative staff experienced greater efficiency, transparency, and accessibility in managing school data. However, the manner in which these impacts are assessed differs between the two institutions. Vocational High School 1 Sidoarjo employs data-based evaluation through LMS utilization, CBT implementation, and digital monitoring systems, whereas Vocational High School Mitra Sehat Mandiri places greater emphasis on observable behavioral changes and improvements in work culture. This finding reinforces Ubaedullah et al. (2025), who argued that successful digital transformation should be evaluated not only through quantitative indicators but also through qualitative changes in organizational culture, collaboration, and professional practices.

From a broader perspective, the findings demonstrate that principal support in technology-based school management is shaped by the interaction of leadership practices, organizational structures, and cultural contexts. Mitra Sehat Mandiri Vocational High School represents an adaptive model characterized by flexibility, interpersonal relationships, and gradual technological adoption, while Vocational High School 1 Sidoarjo reflects a systemic model characterized by strategic planning, institutionalized digital systems, and structured implementation. Rather than viewing these approaches as opposing models, the findings suggest that they should be understood as complementary strategies within the spectrum of transformational leadership. This interpretation is consistent with Prianti et al. (2025), who emphasized that digital leadership requires a balance between supportive leadership behaviors and organizational accountability mechanisms.

Overall, this study confirms that no single model of principal support is universally applicable in technology-based school management. Excessive flexibility may hinder standardization and sustainability, whereas excessive systemization may limit creativity and innovation. Therefore, a hybrid leadership model that combines organizational structure with adaptability appears to be the most appropriate approach for supporting sustainable digital transformation. In this regard, transformational principals function not only as managers of technological change but also as catalysts for organizational learning who continuously align strategic vision, human resource development, and technological innovation to meet the evolving demands of digital education. Future research may further explore hybrid leadership models across different educational contexts to identify strategies that effectively balance flexibility, innovation, and institutional sustainability.

Transformational leadership strategies in managing technology-based change

The transformation of technology-based school management extends beyond the mere adoption of digital tools and represents a systemic change involving organizational structures, culture, and educational practices. According to Leithwood et al. (2020), effective school leadership requires the integration of vision, organizational systems, and professional practices, while Dexter and Richardson (2020) argued that technology integration is shaped by the interaction of technological systems, human resources, and managerial processes. This perspective suggests that digital transformation should be understood as a dynamic organizational process rather than a purely technical initiative. Consequently, principals play a strategic role in directing change, fostering organizational readiness, and ensuring that technological innovations contribute to educational improvement.

The findings reveal that both Mitra Sehat Mandiri Vocational High School Sidoarjo and Vocational High School 1 Sidoarjo share a common objective of improving effectiveness and efficiency through technology-based management. However, the two schools demonstrate different transformation pathways. This finding supports Schleicher's (2020) argument that successful digitalization is determined not by technology itself but by how educational organizations manage the accompanying change processes. Although both schools pursued similar goals, their implementation strategies reflected distinct organizational characteristics, leadership orientations, and levels of digital readiness.

Mitra Sehat Mandiri Vocational High School Sidoarjo illustrates a system-driven transformation model in which technology functions as the primary foundation for organizational change. The integration of Google Workspace as the central platform, combined with investments in digital infrastructure and administrative systems, demonstrates a strong emphasis on system integration and operational efficiency. From a managerial perspective, this approach provides advantages in terms of consistency, standardization, and organizational control. However, Trust and Whalen (2021) caution that excessive dependence on technological systems may reduce teachers' professional autonomy and limit opportunities for pedagogical innovation. Therefore, while system-driven transformation contributes to operational stability, it may also risk positioning educators as passive users of technology rather than active agents of change.

In contrast, Vocational High School 1 Sidoarjo reflects a culture-driven transformation approach that prioritizes the development of a shared vision and collective awareness before implementing technological systems. This strategy aligns with Hallinger's (2021) view that successful educational leadership involves shaping organizational culture in addition to managing structures and procedures. By establishing a common understanding of digital transformation, the principal reduced resistance and encouraged broader participation among school members. Such an approach emphasizes that sustainable technological change depends not only on technological readiness but also on cultural acceptance and organizational commitment. Nevertheless, culture-based transformation also presents challenges because cultural change requires a longer period of adaptation and continuous leadership support. Without sufficient structural reinforcement, cultural initiatives may remain symbolic and fail to produce sustainable organizational outcomes.

Despite their different starting points, both schools adopted gradual implementation processes involving planning, training, piloting, and evaluation. This finding is consistent with Fullan et al. (2020), who emphasized that sustainable educational change requires continuous adaptation rather than rapid institutional reform. Gradual implementation enables teachers and staff to develop confidence in using technology while minimizing resistance to change. More importantly, the process functions as organizational learning, allowing schools to refine strategies and address emerging challenges throughout the transformation journey.

The study also confirms that technological transformation is influenced by both technical and human factors. Challenges such as limited infrastructure, variations in digital literacy, financial constraints, and resistance to change were evident in both schools. These findings support Ertmer and Ottenbreit-Leftwich (2020), who argued that barriers to technology integration often originate from beliefs, attitudes, and workplace culture rather than technological limitations alone. Consequently, effective digital transformation requires leadership approaches that address both technological requirements and human adaptation processes simultaneously.

Although both schools relied on training, mentoring, and evaluation as key intervention strategies, their priorities differed. Vocational High School Mitra Sehat Mandiri focused primarily on strengthening technological infrastructure and ensuring system functionality, whereas Vocational High School 1 Sidoarjo emphasized human capacity development through continuous mentoring and the reinforcement of internal IT teams. This finding supports Koehler et al. (2022), who highlight the importance of developing technological and pedagogical competencies simultaneously. The effectiveness of technology-based transformation therefore depends on balancing investments in infrastructure with efforts to enhance human capabilities.

From a broader perspective, the findings indicate that neither system-driven nor culture-driven transformation alone is sufficient to ensure sustainable digital change. System-oriented approaches contribute to organizational efficiency and standardization, while culture-oriented approaches strengthen commitment, collaboration, and adaptability. Rather than viewing these approaches as competing models, the evidence suggests that they should be integrated into a hybrid transformation framework that combines strong organizational systems with a supportive and adaptive culture.

Overall, this study demonstrates that transformational school leadership functions as a strategic bridge between technological systems and organizational culture. Principals are not merely administrators of digital initiatives but change agents who shape vision, facilitate adaptation, and create conditions for continuous innovation. Effective digital transformation therefore extends beyond operational efficiency and contributes to the development of learning organizations capable of responding dynamically to technological advances and future educational demands. Future studies may further explore hybrid transformation models to identify leadership practices that effectively integrate structural, cultural, and pedagogical dimensions within technology-based educational management.

Cross-case propositions and conceptual model

Based on the cross-case analysis of Mitra Sehat Mandiri Vocational High School Sidoarjo and Vocational High School 1 Sidoarjo, six key propositions were developed to explain how transformational leadership supports technology-based school management. First, transformational leadership emerged as the primary driver of successful digital transformation, as principals play a central role in establishing a digital vision, fostering innovation, and encouraging stakeholder engagement. Second, technology-based school management becomes more effective when supported by a systematic, continuous, and data-driven process for identifying the potential of teachers and educational staff. Such identification enables schools to design targeted professional development, allocate responsibilities effectively, and strengthen digital competencies.

Third, continuous principal support through the provision of technological facilities, digital capacity-building programs, mentoring, and evaluation significantly enhances the readiness and adaptability of school members toward digital transformation. Fourth, transformation strategies that are gradual, adaptive, and aligned with organizational characteristics are more likely to produce sustainable change. The findings demonstrate that schools require context-sensitive approaches rather than universal models, as differences in organizational culture, resources, and readiness influence the effectiveness of digital initiatives.

Fifth, successful school digital transformation is determined by the synergy among transformational leadership, organizational culture, human resource readiness, and technological infrastructure. These interconnected factors collectively shape the effectiveness of technology integration in learning, administration, and school governance. Finally, technology-based school management is most effective when digital system development is implemented simultaneously with the strengthening of organizational culture. Balancing system-driven transformation and culture-driven transformation enables schools to achieve greater effectiveness, efficiency, adaptability, and sustainability in responding to technological advancements.

Based on these findings, several propositions were formulated to construct a conceptual model of technology-based school management transformation through transformational leadership.

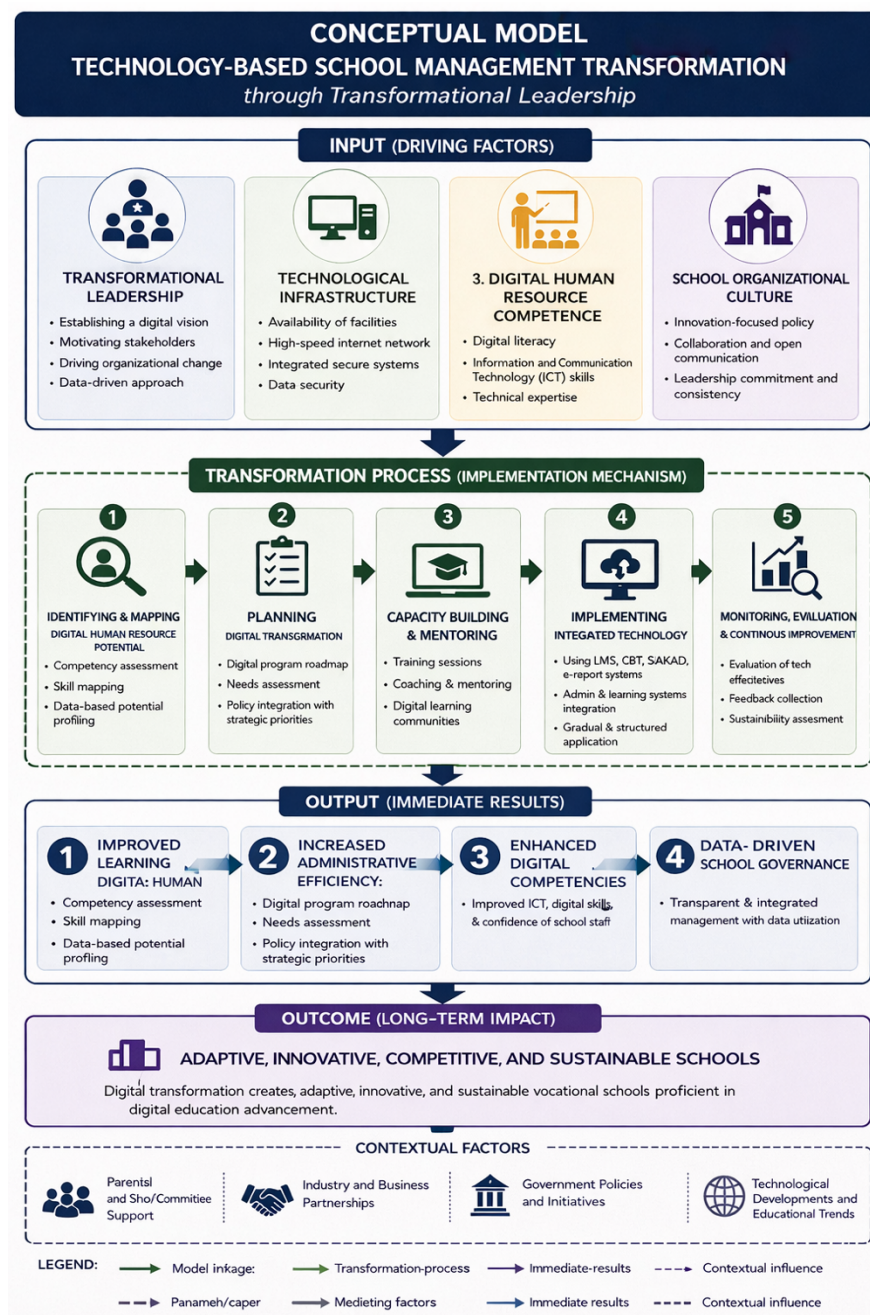


Figure 1. Conceptual model technology-based school management transformation through transformational leadership

CONCLUSION

Fundamental Finding : This study concludes that transformational leadership is a critical determinant of successful technology-based school management transformation in vocational education. The findings from Mitra Sehat Mandiri Vocational High School Sidoarjo and Vocational High School 1 Sidoarjo demonstrate that digital transformation extends beyond the adoption of technological tools and requires the integration of leadership, organizational culture, human resource readiness, and technological infrastructure. While Mitra Sehat Mandiri Vocational High School Sidoarjo represents a gradual and adaptive transformation model and Vocational High School 1 Sidoarjo reflects a more systematic and integrated approach, both cases confirm that effective digital transformation depends on the principal's ability to establish a digital vision, support capacity development, encourage stakeholder participation, and create an environment conducive to innovation. **Implications :** These findings contribute to the literature by reinforcing the role of transformational leadership as a catalyst for organizational change in the digital era and suggest that sustainable school transformation requires a balanced integration of system-driven and culture-driven approaches. **Limitations :** However, this study is limited by its focus on two vocational schools and by the exclusion of broader stakeholder perspectives, such as students, parents, and industry partners, which may limit the transferability of the findings to other contexts. **Future Research :** should therefore involve a larger number of schools, apply longitudinal designs, and incorporate multiple stakeholder perspectives to gain a more comprehensive understanding of digital transformation processes and to further examine the effectiveness of hybrid leadership and management models in supporting sustainable educational innovation. Ultimately, the study highlights that the long-term success of technology-based school management lies not in technology itself, but in transformational leadership that effectively aligns digital systems, organizational culture, and human capacity toward a shared vision of adaptive, innovative, and sustainable education.

AUTHOR CONTRIBUTIONS

Yohanes Eko Prasetyo; Conceptualization, literature investigation and data curation, Yohanes Eko Prasetyo; formal analysis. **Yatim Riyanto;** writing—original draft preparation, writing—review and editing. **Nunuk Hariyati;** visualization, supervision and validation. All authors have read and approved the final version of the manuscript.

CONFLICT OF INTEREST STATEMENT

The authors declare that there are no financial or personal conflicts of interest related to this research. The authors confirm that no external interests have influenced the research process, analysis, interpretation of findings, or publication of this manuscript.

ETHICAL COMPLIANCE STATEMENT

This study was conducted in accordance with research and publication ethics. The authors confirm that the research was performed with academic integrity, maintained the confidentiality of participant information, and obtained appropriate permission from the participating vocational high schools. This manuscript represents original work and is free from unethical practices, including plagiarism, fabrication, or manipulation of research data.

STATEMENT ON THE USE OF AI DIGITAL TOOLS IN WRITING

The authors acknowledge the use of ChatGPT (OpenAI) as a language-support tool during the preparation of this manuscript. The tool was used solely for language refinement, grammar improvement, and enhancing the clarity and readability of the manuscript. ChatGPT was not involved in the research design, data collection, data analysis, interpretation of findings, development of the conceptual model, or generation of research results. All AI-assisted suggestions were critically reviewed, verified, and revised by the authors to ensure accuracy, academic integrity, and compliance with ethical publication standards. The authors take full responsibility for the content, analysis, and conclusions presented in this manuscript.

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