The Influence of Individual Skills, Organizational Structure, and External Environment on the Digital Leadership of School Principals in Deli Serdang

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Abstract *: This study aims to analyze the influence of individual skills, organizational structure, and external environment on the digital leadership of school principals in Deli Serdang Regency. The study employed a quantitative approach with a causal-associative design involving 181 junior high school principals selected through systematic sampling. Data were collected using questionnaires and analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM). The findings reveal that individual skills, organizational structure, and external environment have positive and significant effects on digital leadership. Among these variables, individual skills emerged as the most dominant factor influencing principals' digital leadership. Furthermore, the R-square value of 0.67 indicates that 67% of the variance in digital leadership can be explained by these three variables, while the remaining 33% is influenced by other factors outside the research model. These findings highlight that strengthening individual competencies, supported by adaptive organizational structures and a conducive external environment, is essential for enhancing the effectiveness of digital leadership in schools.*

Keywords : *Digital Leadership, External Environment, Individual Skills, Organizational Structure.*

Abstrak : Penelitian ini bertujuan menganalisis pengaruh skill individu, struktur organisasi, dan lingkungan eksternal terhadap kepemimpinan digital kepala sekolah di Kabupaten Deli Serdang. Penelitian menggunakan pendekatan kuantitatif dengan desain asosiatif kausal terhadap 181 kepala sekolah SMP yang dipilih melalui teknik systematic sampling. Data dikumpulkan menggunakan kuesioner dan dianalisis menggunakan Structural Equation Modeling berbasis Partial Least Squares (PLS-SEM). Hasil penelitian menunjukkan bahwa skill individu, struktur organisasi, dan lingkungan eksternal berpengaruh positif dan signifikan terhadap kepemimpinan digital. Di antara ketiga variabel tersebut, skill individu merupakan faktor yang paling dominan dalam membentuk kepemimpinan digital kepala sekolah. Selain itu, nilai R-square sebesar 0,67 menunjukkan bahwa 67% variasi kepemimpinan digital dapat dijelaskan oleh ketiga variabel tersebut, sedangkan sisanya dipengaruhi oleh faktor lain di luar model penelitian. Temuan ini menegaskan bahwa penguatan kompetensi individu, didukung oleh struktur organisasi yang adaptif dan lingkungan yang kondusif, menjadi faktor penting dalam meningkatkan efektivitas kepemimpinan digital di sekolah.

Kata Kunci : Kepemimpinan Digital, Lingkungan Eksternal, Skill Individu, Struktur Organisasi.

INTRODUCTION

The development of digital technology has brought big changes in the world of education, both in the learning process and in school management (Yuan & Wang, 2025). This situation requires principals to be able to adapt to technological developments by applying digital leadership. Digital leadership is the principal's ability to use information and communication technology to improve the effectiveness of school management (Berkovich & Hassan, 2025), supporting learning innovation, as well as driving sustainable educational transformation. The success of a principal's digital leadership is influenced by various factors. One of them is individual skills, which include digital competence, managerial ability, communication, and adaptability to technological changes. Principals with good digital skills tend to be more effective in implementing technology-based programs in schools (Harefa, et al., 2026).

Organizational structure also plays an important role in supporting digital leadership. A flexible, collaborative, and innovation-friendly organizational structure makes it easier for school principals to manage change and develop a digital culture in the school environment (Ruloff & Petko, 2025). On the other hand, an overly bureaucratic structure can slow down the digital transformation process. Other factors include the external environment, such as government policies, technological developments, community support, and the demands of the education world. A supportive external environment can encourage schools to adopt technology faster and improve the quality of educational services (Banoğlu, Vanderlinde, & Aesaert, 2022).

In Deli Serdang Regency, the implementation of digital education shows varying levels of readiness among schools. Differences in principals' competencies, organizational support, and external environmental conditions are challenges in realizing effective digital leadership. Therefore, research on the influence of individual skills, organizational structure, and the external environment on the digital leadership of principals in Deli Serdang is important to understand the factors that contribute to successful digital transformation in schools and to serve as a basis for developing education policies that are more adaptive to the digital era.

Previous research (Zahro, Andriani, & Raihan, 2025) shows that an individual's competence or a leader's digital skills affect the effectiveness of digital leadership. However, research (Paramansyah, 2026) still focuses on individual factors and hasn't comprehensively examined the influence of organizational factors and external environment on digital leadership. In fact, organizational theory states that a leader's success is not only determined by individual capacity, but also by the support of the organizational structure and the surrounding environmental conditions (Karakose, Polat, Tülübaş, & Demirkol, 2024).

Research (khabareh, 2026), carried out in the business, industry, and higher education sectors, while studies on school principals' digital leadership at the primary and secondary education levels are still relatively limited. In addition, research discusses the relationship between digital leadership and school performance, educational innovation, or digital transformation, while research (Ridho, Wiyono, & Mustiningsih, 2024) Research that considers individual skills, organizational structure, and external environment as determining factors for a principal's digital leadership is still rare. This situation shows a research gap that needs to be filled to broaden understanding of the factors that influence the success of digital leadership in the educational environment.

Another gap lies in the geographical context of the research. Studies on digital leadership in Indonesia are still dominated by urban areas and educational institutions with relatively high levels of technological readiness. Meanwhile, research specifically examining the digital leadership of school principals in Deli Serdang Regency is still very limited. In fact, schools in Deli Serdang have diverse conditions in terms of infrastructure, human resources, and access to technology, which can affect the implementation of digital leadership. Therefore, research that can provide empirical evidence on the factors influencing school principals' digital leadership in that area is needed.

Based on the explanation, the novelty of this study lies in integrating three main variables individual skills, organizational structure, and external environment into a single research model to explain school principals' digital leadership. Unlike previous studies that tend to examine these factors separately, this study tests the influence of all three variables simultaneously, resulting in a more comprehensive model for understanding the determinants of digital leadership in schools. Additionally, the study's novelty also comes from its research subject, namely school principals in Deli Serdang Regency, who have not been widely studied in the context of digital leadership. Thus, this study is expected to enrich the literature on digital leadership in education management while also providing practical recommendations for developing school principals' competencies, strengthening school organizational structures, and optimizing support from the external environment to speed up the digital transformation of education.

RESEARCH METHOD

This study uses a quantitative approach with associative causal research to test the influence of individual skills, organizational structure, and external environment on school principals' digital leadership. A quantitative approach was chosen because it allows objective testing of relationships between variables through numerical data analyzed using statistical techniques. According to Sugiyono, quantitative research is a research method used to test theories through variable measurement and statistical data analysis, while associative causal research aims to understand the cause-and-effect relationships between research variables (Sugiyono, 2024).

The research was conducted at the Deli Serdang Regency Education Office, North Sumatra, from February to May 2026. The research process included preparing the instruments, collecting data, analyzing data, and systematically compiling the research report (Creswell, 2024). The research population consists of all junior high school principals under the Deli Serdang District Education Office, totaling 359 people. The research sample was determined based on the Krejcie and Morgan table, resulting in 181 respondents with a 5% margin of error. The sampling technique used was systematic sampling to give every member of the population a proportional chance to become a research respondent (Krejcie & Morgan, 1970).

The independent variables in this study consist of individual skills (X_1), organizational structure (X_2), and external environment (X_3), while the dependent variable is the principal's digital leadership (Y). The operationalization of the variables is based on indicators relevant to each construct and is measured using a five-point Likert scale questionnaire. Research data was collected through questionnaires distributed both directly and via Google Form. The research instruments were developed based on theoretical indicators derived from various literature related to individual competence, organizational structure, external environment, and digital leadership. Data analysis was done using Partial Least Squares-based Structural Equation Modeling (PLS-SEM) with the help of SmartPLS software. This method is used to test the relationships between latent variables and also to evaluate the research model. Model testing includes evaluating the measurement model (outer model) and the structural model (inner model). Relationships between variables are considered significant if they have a p-value < 0.05 (Hair, Black, Babin, & Anderson, 2019).

RESULTS AND DISCUSSION

Results

Measurement Model Test

Table 1. Results of Validity and Reliability Tests

Variable	Indicator	Outer Loading	AVE	Cronbach's Alpha	Composite Reliability	Description
Individual Skills (X1)	X1.1	0.842	0.625	0.89	0.92	Valid & Reliable
	X1.2	0.817				
	X1.3	0.791				
	X1.4	0.762				

Organizational Structure (X2)	X2.1	0.845	0.680	0.90	0.93	Valid & Reliable
	X2.2	0.822				
	X2.3	0.798				
	X2.4	0.758				
External Environment (X3)	X3.1	0.815	0.660	0.88	0.91	Valid & Reliable
	X3.2	0.802				
	X3.3	0.780				
	X3.4	0.743				
Digital Leadership (Y)	Y1	0.867	0.700	0.91	0.94	Valid & Reliable
	Y2	0.835				
	Y3	0.825				
	Y4	0.789				

Source: Processed data (2026)

The measurement model test was carried out to ensure that all research constructs have adequate levels of validity and reliability before testing the structural model. The analysis results show that all indicators for the variables of Individual Skills, Organizational Structure, External Environment, and Digital Leadership meet the convergent validity criteria, as indicated by outer loading values above the required minimum threshold. In addition, the Average Variance Extracted (AVE) values for all constructs also meet the criteria, meaning each variable can adequately explain the variance of its indicators. From the reliability aspect, all variables showed a very good level of internal consistency. The Cronbach's Alpha and Composite Reliability values for each construct have exceeded the recommended threshold, so the research instrument is considered reliable and capable of producing consistent measurements. Among all the constructs tested, the Digital Leadership and Organizational Structure variables showed the relatively highest reliability, indicating a strong connection among the indicators in representing those constructs.

Overall, the results of the measurement model testing show that all indicators and constructs in this study have met the validity and reliability requirements. Therefore, the research instrument is considered suitable for further analysis in the structural model to examine the influence of Individual Skills, Organizational Structure, and External Environment on the Digital Leadership of Principals in Deli Serdang Regency.

Structural Model Test

Table 2. Results of Path Coefficient Test and Significance

Variable Relationship	Path Coefficient	T-Statistic	P-Value	Description
$X_1 \rightarrow Y$ (Individual Skills → Digital Leadership)	0.42	5.87	0.000	Significant
$X_2 \rightarrow Y$ (Organizational Structure → Digital Leadership)	0.35	4.92	0.000	Significant
$X_3 \rightarrow Y$ (External Environment → Digital Leadership)	0.28	3.76	0.001	Significant

Source: Processed data (2026)

The structural model analysis was conducted to examine the effects of Individual Skills, Organizational Structure, and External Environment on Principals' Digital Leadership. The results revealed that all relationships among the variables were positive and statistically significant, indicating that all research hypotheses were supported. These findings suggest that improvements in individual competencies, the presence of an adaptive organizational structure, and a supportive external environment contribute significantly to strengthening digital leadership.Among the three independent variables, Individual Skills emerged as the most dominant factor influencing digital

leadership. This finding indicates that principals' digital competencies, adaptability, and managerial skills play a crucial role in driving the success of digital transformation within schools. The higher the level of individual capabilities possessed by principals, the more effective the implementation of digital leadership practices.

In addition, Organizational Structure was found to have a significant contribution to digital leadership. A flexible, collaborative, and innovation-oriented organizational structure enables decision-making processes to become more responsive to technological advancements. Such conditions create a work environment that facilitates the effective implementation of digital leadership practices. The External Environment also demonstrated a significant influence on digital leadership, although its contribution was relatively lower compared to the other variables. Government policies, technological developments, and societal demands serve as important drivers that encourage principals to continuously adapt and develop innovations in educational management.

Overall, the findings confirm that digital leadership is influenced not only by the individual capabilities of leaders but also by organizational support and external environmental factors. Nevertheless, the dominant effect of Individual Skills highlights that the success of digital transformation in schools depends largely on the quality of human resources as the primary agents of change. These findings imply that enhancing principals' digital competencies should be prioritized, alongside strengthening organizational structures and fostering a supportive environment for digital-based educational transformation.

Coefficient of Determination (R-Square)

The determination coefficient (R-Square) in this study is used to measure how well the independent variables can explain the variability of the dependent variable, which is digital leadership. This value is an important indicator in evaluating the structural model because it provides an idea of the predictive power of the model that was built. The higher the R-Square value, the greater the contribution of the exogenous variables in explaining changes in the endogenous variable.

Table 3. R-Square Value

Dependent Variable	R^2	Interpretation
Digital Leadership (Y)	0.67	Strong

Source: Data processed (2026)

Based on the analysis results presented in Table 3, the R-Square value for the Digital Leadership variable (Y) is 0.67. This value falls within the strong category, indicating that the research model possesses a high level of explanatory power. In other words, 67% of the variation in Digital Leadership can be simultaneously explained by the three independent variables, namely Individual Skills, Organizational Structure, and External Environment. This finding suggests that the combination of these three variables makes a substantial contribution to shaping and influencing digital leadership practices, particularly within the educational context. Individual Skills provide the competencies that enable leaders to adapt to technological advancements, Organizational Structure offers a supportive framework for leadership implementation, and the External Environment presents both pressures and opportunities that drive digital transformation.

However, 33% of the variance in Digital Leadership remains unexplained by the model. This indicates the presence of other factors beyond the variables examined in this study that may also influence digital leadership. Such factors may include organizational culture, leadership style, technological support, educators' digital literacy, and broader educational policies. Therefore, although the proposed model demonstrates strong explanatory capability, there remains room for the development of a more comprehensive model in future research. Overall, the R-Square value of 0.67 confirms that the research model has an adequate level of accuracy in explaining the phenomenon of Digital Leadership. This finding not only strengthens the empirical validity of the model but also provides a solid foundation for strategic decision-making aimed at enhancing the quality of digital leadership within educational institutions.

Research Model Visualization

The visualization of the research model is a conceptual representation that shows the causal relationships between the variables being studied, making it easier to understand the direction, strength, and pattern of influence in the model. In Figure 1, it is shown that digital leadership as the dependent variable is directly influenced by three independent variables: individual skills (X_1), organizational structure (X_2), and external environment (X_3). This model emphasizes that digital leadership doesn't exist in isolation but is the result of the interaction of various multidimensional factors.

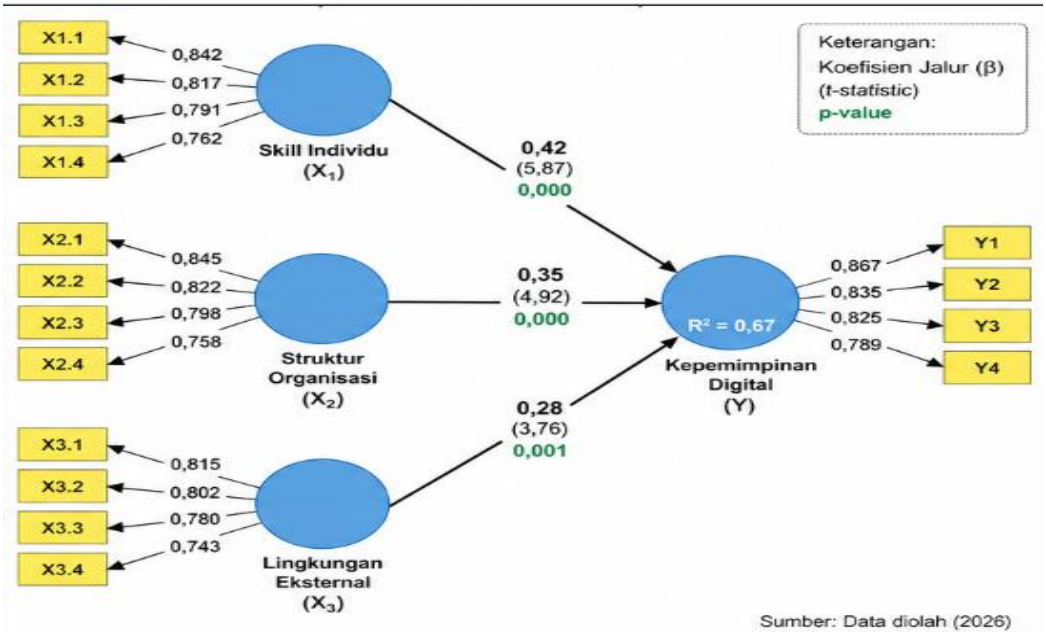

Figure 1. Model of Influence Between Variables

Based on the visualization, it can be observed that all independent variables have a positive influence on Digital Leadership. This indicates that improvements in each variable are associated with enhancements in the quality of principals' digital leadership. However, the strength of the relationships varies considerably across the variables. Individual Skills (X_1) emerge as the most dominant factor, as evidenced by the highest path coefficient. This finding highlights that personal competencies, such as digital literacy, adaptability to technological change, and data-driven decision-making abilities, are the primary drivers of effective digital leadership. In other words, digital transformation in educational leadership largely depends on the capacity of individuals to act as agents of change.

On the other hand, Organizational Structure (X_2) also makes a substantial contribution to the model. A flexible organizational structure, effective coordination systems, and a collaborative work culture enable the implementation of digital policies to be carried out more effectively. Adaptive organizations facilitate the integration of technology into daily leadership practices and accelerate the adoption of digital innovations. Meanwhile, although the External Environment (X_3) exhibits the smallest effect among the independent variables, it still plays a strategic role in shaping digital leadership. Factors such as technological advancements, government policies, and societal expectations serve as external stimuli that encourage leaders to continuously innovate and adapt to changing conditions.

Overall, the visualization of the research model provides a comprehensive understanding that Digital Leadership is the result of the synergy among individual, organizational, and environmental factors. The dominant influence of Individual Skills suggests that investment in human resource competency development should be a primary priority, while still recognizing the importance of organizational support systems and the dynamics of the external environment. Therefore, this model is not only descriptive in nature but also offers strategic guidance for the advancement of educational leadership in the digital era.

Hypothesis Test (Bootstrapping)

Table 4. Hypothesis Test Results (Bootstrapping)

Hypothesis	Variable Relationship	Path Coefficient (β)	T-Statistic	P-Value	Decision
H1	$X_1 \rightarrow Y$	0.42	5.87	0.000	Accepted
H2	$X_2 \rightarrow Y$	0.35	4.92	0.000	Accepted
H3	$X_3 \rightarrow Y$	0.28	3.76	0.001	Accepted

Based on the hypothesis testing results using the bootstrapping method presented in Table 4, all hypotheses in this study were supported. This is evidenced by the t-statistic values exceeding 1.96 and the p-values being below 0.05, indicating that all relationships among the variables are statistically significant. Specifically, the first hypothesis (H1), which examined the effect of Individual Skills (X_1) on Digital Leadership (Y), yielded a path coefficient of 0.42, a t-statistic of 5.87, and a p-value of 0.000. These results indicate that Individual Skills have a positive and significant effect on Digital Leadership. In other words, higher levels of individual competence are associated with stronger and more effective digital leadership practices.

The second hypothesis (H2), which investigated the effect of Organizational Structure (X_2) on Digital Leadership (Y), produced a path coefficient of 0.35, a t-statistic of 4.92, and a p-value of 0.000. This finding demonstrates that Organizational Structure has a positive and significant influence on Digital Leadership. It suggests that a well-designed and adaptive organizational structure can effectively support the implementation of digital leadership practices. Meanwhile, the third hypothesis (H3), which tested the effect of the External Environment (X_3) on Digital Leadership (Y), generated a path coefficient of 0.28, a t-statistic of 3.76, and a p-value of 0.001. These results also indicate a positive and significant effect, although the magnitude of the influence is relatively smaller compared to the other independent variables. Overall, the findings reveal that all independent variables Individual Skills, Organizational Structure, and External Environment make significant contributions to the development of Digital Leadership. Among these variables, Individual Skills (X_1) emerged as the most influential factor, highlighting the critical role of leaders' competencies in driving successful digital leadership within educational institutions.

Discussion

The research results show that individual skills, organizational structure, and the external environment have a positive and significant effect on school principals' digital leadership. These findings indicate that the success of digital transformation in education is not only determined by the availability of technology but is also influenced by the readiness of individual leaders, organizational support, and the school's ability to respond to a dynamic environment. This aligns with the view that digital leadership is a multidimensional process involving the interaction between personal, organizational, and external environmental factors in driving technology-based change. The most important finding in this study is the dominant influence of individual skills on the digital leadership of school principals. This result shows that the personal abilities of the principal are the main foundation for successfully implementing digital leadership. In the era of digital transformation, principals no longer just act as educational administrators, but also as change agents who can integrate technology into school management processes, decision-making, organizational communication, and digital-based learning development. Competencies such as digital literacy, strategic thinking skills, communication skills, creativity, problem-solving abilities, and adaptability to change are key assets in building effective digital leadership.

These findings support the research (Rikkerink, Verbeeten, Simons, & Ritzen, 2016) which emphasizes that digital leaders must have the ability to manage change by strategically leveraging technology. The results of this study also align with researc (Araujo, Priadana, Paramarta, & Sunarsi, 2021) who found that individual competence is the most determining factor in the success of digital leadership in the Industrial Revolution 4.0 era. Likewise, research (Zuhairi & Iskandar, 2026) It shows that an organization's digital transformation heavily depends on the leader's ability to understand technology and turn it into innovative organizational strategies. In the education context, school principals with high digital competence tend to find it easier to foster an innovative

culture, improve teachers' work effectiveness, and encourage the use of technology in the learning process. The dominance of individual skill influence in this study also indicates that the biggest investment in developing digital leadership should be directed at improving the quality of human resources. This is important considering that many educational digitalization programs often focus more on providing technological infrastructure rather than strengthening user competencies. In fact, advanced technology won't deliver optimal benefits without adequate individual capabilities to manage it. Therefore, developing digital competencies of school principals through ongoing training, digital leadership certification, coaching, and professional development programs becomes a very strategic necessity.

Besides individual skills, organizational structure also proves to have a significant impact on a principal's digital leadership. This finding shows that the success of digital leadership cannot be separated from the support of an organizational system that allows innovation and collaboration to happen. A flexible organizational structure, open communication, clear division of tasks, and a work culture that supports continuous learning will create a conducive environment for implementing digital technology in schools. The results of this study reinforce the organizational behavior theory proposed by (Iskandar, Mesiono, & Sit, 2025) that the effectiveness of leadership is greatly influenced by the organizational design where the leader operates. This finding is also consistent with research (Nurwahyuni, Mustiningsih, & Triwiyanto, 2025) which explains that digital leadership in education requires support from an organizational system that can facilitate collaboration, innovation, and technology integration. Schools with adaptive organizational structures tend to respond to changes faster and are more effective in implementing technology-based policies compared to bureaucratic and rigid organizations.

In the context of education in Deli Serdang Regency, this finding shows that digital transformation can't rely solely on the abilities of individual principals. It also requires restructuring the school organization to support technology development, including forming a digital transformation team, strengthening coordination between work units, and creating an organizational culture that encourages innovation. This way, successful digital leadership becomes a shared responsibility of all elements of the school organization. This study also found that the external environment has a significant impact on digital leadership. The results show that factors outside the school, like technological developments, government policies, societal demands, and changes in educational needs, also shape the behavior and strategies of school principals. Even though its contribution is relatively smaller compared to individual skills and organizational structure, the external environment still plays an important role as a driver of digital transformation.

Temuan ini sejalan dengan penelitian (Kurniawan, Solehan, & Lazwardi, 2025) which states that changes in the external environment have become one of the main factors driving innovation in educational leadership. Research (Margana, Hidayati, & Suyatno, 2024) also explains that effective educational leaders are those who can read changes in the environment and respond to them through relevant innovation. In today's digital era, the rapid development of technology demands that school principals keep learning, adapt, and develop new strategies so that schools remain competitive and relevant to students' needs. Furthermore, the research results show that these three variables together can explain most of the variation in principals' digital leadership. This finding supports the contingency approach in leadership theory, which states that leadership effectiveness is not determined by a single factor, but by a combination of various interacting factors (Frizdew, Arifah, Gistituati, Rusdinal, & Nellitawati, 2025). Effective digital leadership emerges when school principals have adequate competence, supported by an adaptive organizational structure, and are in an environment that encourages innovation and change.

Practically, the results of this study have important implications for the development of education in Deli Serdang Regency. First, the Education Office needs to make strengthening school principals' digital competence a priority program through continuous digital leadership training. Second, schools need to develop a more flexible and collaborative organizational structure to be able to accommodate various digital innovations. Third, a stronger synergy is needed between schools, the government, the community, and the tech sector to create a sustainable digital education ecosystem. In the end, this study emphasizes that digital leadership is a strategic

competency that is highly needed to face the challenges of 21st-century education. The success of digital transformation in schools doesn't just depend on the available technology, but mainly on the quality of the people managing it, the organizations supporting it, and the environment that encourages continuous innovation. These findings make an important contribution to the development of digital leadership theory and also serve as a basis for formulating education policies that are more adaptive to technological developments and future demands.

CONCLUSION

Based on the research results, it can be concluded that individual skills, organizational structure, and the external environment have a positive and significant impact on the digital leadership of school principals in Deli Serdang Regency. Among these three variables, individual skills are the most dominant factor in shaping digital leadership, showing that digital competence, adaptability, and managerial skills of school principals are key to the success of digital transformation in the educational environment. In addition, an adaptive organizational structure and a supportive external environment also contribute to strengthening the implementation of digital leadership. These research results imply the importance of continuously developing the digital competence of school principals, along with strengthening the school organizational system and policy support that encourages technology-based educational innovation. However, this study is still limited to junior high school principals in the Deli Serdang Regency and only examines three independent variables, so the results cannot yet be fully generalized to a broader context. Therefore, future research is advised to involve a wider range of regions and educational levels, and to add other variables, such as organizational culture, teachers' digital literacy, technology readiness, and leadership style, in order to obtain a more comprehensive and in-depth digital leadership model.

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