Journal of Education and Teaching (JET)
Vol. 7 No. 2 2026

Does the Principal's Digital Planning Capacity Play a Role in Achieving Effective Schools?

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Draft article history
Submitted: 03-04-2026;
Revised: 06-12-2026;
Accepted: 06-14-2026;

ABSTRACT: This study examines the digital planning capabilities of school principals, the use of digital infrastructure, the Teachers' Acceptance of Digital Aspects, the Principals' Courage to Take Risks, and their impact on school effectiveness in West Java. The research method used is an associative quantitative approach and the type of research used is an explanatory survey, namely a survey that aims to explain the relationship between variables. The study involved 177 school principals, the study involved school principals at various levels of education (elementary, junior high, senior high, and vocational high schools). Respondents came from various regions in West Java, with respondents predominantly from Sumedang, Purwakarta, Bogor Regency, and the surrounding areas. The results showed that the model used was valid, reliable, free from multicollinearity, had strong predictive power, and fit the data. School effectiveness was positively and significantly influenced by the Principal's digital planning capability, teacher acceptance of digital aspects, and Principals' Courage to Take Risks. The use of digital infrastructure had a positive but insignificant effect. The model was able to explain 60.1% of the variation in school effectiveness.

Keywords: digital planning capability, educational techology acceptability, school effectiveness.

ABSTRAK: *Penelitian ini mengkaji kemampuan perencanaan digital kepala sekolah, pemanfaatan infrastruktur digital, penerimaan aspek digital oleh guru, keberanian kepala sekolah dalam mengambil risiko, serta pengaruhnya terhadap efektivitas sekolah di Jawa Barat. Metode penelitian yang digunakan adalah pendekatan kuantitatif asosiatif dengan jenis penelitian survei eksplanatori, yaitu survei yang bertujuan menjelaskan hubungan antarvariabel. Penelitian ini melibatkan 177 kepala sekolah dari berbagai jenjang pendidikan, yaitu sekolah dasar, sekolah menengah pertama, sekolah menengah atas, dan sekolah menengah kejuruan. Responden berasal dari berbagai wilayah di Jawa Barat, dengan mayoritas berasal dari Kabupaten Sumedang, Purwakarta, Kabupaten Bogor, dan wilayah sekitarnya. Hasil penelitian menunjukkan bahwa model yang digunakan valid, reliabel, bebas dari multikolinearitas, memiliki daya prediksi yang kuat, dan sesuai dengan data. Efektivitas sekolah dipengaruhi secara positif dan signifikan oleh kemampuan perencanaan digital kepala sekolah, penerimaan aspek digital oleh guru, dan keberanian kepala sekolah dalam mengambil risiko. Pemanfaatan infrastruktur digital menunjukkan pengaruh positif, namun tidak signifikan. Model penelitian mampu menjelaskan 60,1% variasi efektivitas sekolah.*

Kata Kunci: *kemampuan perencanaan digital, penerimaan teknologi pendidikan, efektivitas sekolah.*

INTRODUCTION

Digital transformation in education has become an urgent need in the era of the Industrial Revolution 4.0 and Society 5.0. Schools are not only required to

adopt technology in the learning process but also in managerial governance, including planning, infrastructure management, and decision-making systems. Amid these changes, school principals play a central role in ensuring that the digital transformation process is strategic and sustainable. The development of digital technology has generated significant interest and discussion across various sectors, including education. The world of education is no longer dependent on conventional methods. This change also requires a shift in the role of teachers, from mere instructors to facilitators and mentors in the digital learning space (Akfal et al., 2025; Ally & Wark, 2020; Schwab, 2017).

Research on digital transformation has been largely conducted in the industrial sector, while studies in education, particularly schools, are still limited. Findings from the manufacturing sector indicate that accelerating digitalization without core capability readiness can undermine performance (Carmo et al., 2025; Demastus et al., 2025; Zhao et al., 2025; Zhong & Zhang, 2025).

This condition is relevant for schools in West Java, where digitalization of education often occurs quickly but is not always accompanied by the planning capabilities of school principals, optimization of digital facilities, teacher acceptance, and the Principals' Courage to Take Risks. Previous research has tended to examine these factors separately and rarely analyzed their collective influence on school effectiveness, so comprehensive studies are needed that fill these gaps.

The principal's role as a school leader encompasses planning, organizing, directing, coordinating, and supervising activities. This means that by creating a program plan, the principal can estimate, prepare, and determine what actions will be taken during the program's implementation process (As'ad et al., 2018; Zahro & Wahid, 2017).

A principal's digital planning capabilities are fundamental to designing a school's direction and strategy in the digital age. These capabilities encompass the ability to identify technology needs, develop data-driven programs, and adapt school planning to dynamic technological developments. Without adequate digital planning capabilities, schools potentially face a gap between 21st-century educational needs and actual implementation. The digitalization of education has undoubtedly brought significant changes to principal leadership in today's modern era, where principals are challenged to effectively integrate digital technology into the learning process and school management (Darwis et al., 2024; Khan & Ahmad, 2021).

On the other hand, the use of digital facilities and infrastructure also plays a crucial role in supporting learning activities and school administration. Available technological infrastructure, such as computers, internet connections, and digital learning platforms, must be optimally utilized to create an adaptive and innovative learning environment. Managing digital-based facilities and infrastructure requires other supporting variables, such as information systems, which are part of the infrastructure system and cannot stand alone but are interconnected (Sumarjono, 2023). However, the existence of digital facilities does not necessarily guarantee increased school effectiveness if it is not supported by targeted use.

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Thus, having adequate facilities and infrastructure is crucial for improving learning effectiveness. Proper management of digital facilities and infrastructure will increase efficiency. For example, teachers can save time and effort by automating and integrating grade recording, attendance tracking, and performance reporting processes. Furthermore, online professional development activities, including webinars, courses, and digital learning communities, are readily available for those who need them (Djunaedi et al., 2023; Manap, 2023; Mohzana et al., 2025; Ramli et al., 2024).

Digital acceptance in schools faces complex challenges, one of which is the generation gap between teachers and students, which impacts their ability to adapt to learning technologies. Older-generation teachers generally lack confidence and feel less competent in using ICT, while digital-generation students adapt more quickly, creating inequalities in the learning process (Khodir et al., 2024; Pardede & Sunarto, 2020). Furthermore, limited skills, infrastructure, and suboptimal training are major barriers to integrating digital applications in the classroom (Azizi et al., 2024). Cost and risk factors also influence teachers' decisions not to adopt technology, as they are perceived as expensive and have the potential to negatively alter students' learning habits (Hermita et al., 2023). Teachers' intention to use digital technology is more influenced by perceived benefits, ease of use, and environmental support than demographic factors. Therefore, policy interventions need to focus on improving digital literacy, providing relevant training, and systemic support for effective digital transformation in education.

Previous research has shown that digital acceptance in schools is influenced by generational gaps, limited teacher digital literacy, inadequate infrastructure, perceived benefits, and concerns about costs and risks. However, most studies have focused on the teacher and student levels. Few studies have examined the strategic role of school principals, particularly digital planning capabilities and risk-taking skills, as determining factors for the success of educational technology transformation. This study fills this gap by analyzing the relationship between principals' digital planning capabilities, digital infrastructure utilization, teachers' digital acceptance, and risk-taking skills on school effectiveness in West Java.

Previous research has discussed digital literacy and infrastructure in a macro context but has not examined the role of school management. Andersen et al. (2024) focused on developed countries, Feng et al. (2025) on the impact of infrastructure on income inequality, and Kibinda et al. (2025) on the technical aspects of infrastructure in rural areas. No research has yet examined the relationship between principals' digital planning capabilities, digital resource utilization, teacher acceptance of technology, and risk-taking skills on school effectiveness in West Java.

The success of digital transformation is also determined by the Teachers' Acceptance of Digital Aspects as key actors in the learning process. Teacher acceptance of technology reflects the extent to which they are ready to adapt to change, as well as their openness to training and innovation in digital-based learning. This factor is crucial for the successful implementation of digital

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DOI: 10.51454/jet.v7i2.932

programs in schools, as teacher resistance can hinder the effective use of technology. This is because integrating technology into education has become a crucial requirement for adapting to changing generational needs to improve the learning environment (Masaeed et al., 2025).

Furthermore, the courage of principals and teachers in taking digital risks is an important indicator of a growing culture of innovation within the school environment. Courage to try new technologies, adopt unfamiliar learning approaches, or implement digital work system changes requires a visionary leadership mentality and support for experimentation. Without the Principals' Courage to Take Risks, innovation in digital education will be slow and limited to conventional practices. Emerging technologies will continue to advance work methods, necessitating the reengineering of organizational systems and processes through sophisticated systems aimed at serving effectively and efficiently (Alghamdi, 2022; Gopal, 2020).

West Java Province, which has one of the largest numbers of schools in Indonesia, exhibits varying dynamics in the implementation of educational digitalization across districts/cities. The 2023 West Java Education Profile data reveals that these differences are evident in the level of technology adoption in learning, the quality of digital resource management, and the sustainability of implemented programs (Disdik Jabar, 2023). The Ministry of Education, Culture, Research, and Technology (Kemendikbudristek) report (2023) confirms that some schools have achieved high effectiveness in digital-based learning through thorough strategic planning, optimal infrastructure utilization, and the active involvement of all stakeholders. However, many other schools still lag behind in managerial and operational aspects, such as low technology integration into the curriculum, minimal teacher digital competency training, and limited supporting infrastructure (Kemendikbudristek, 2023).

School effectiveness in the digital era is not only determined by students' academic achievements but also encompasses other aspects such as management efficiency, the level of student engagement in the learning process, and the ability of all school elements to adapt to changes in the highly dynamic technological environment. Effective schools today are those that are able to utilize digital technology not only as a learning tool but also as an instrument to improve coordination, transparency, and accountability in the management of educational resources. Furthermore, school effectiveness can be seen from internal and external factors within the school environment (Ali et al., 2017; Bryson, 2018; Cheng, 2022).

Thus, investigating the relationship between principals' planning and leadership capabilities, the availability and effective utilization of digital infrastructure, teachers' acceptance of and readiness for digital innovation, and their willingness to take risks is crucial. Such research can offer a more comprehensive understanding of the factors that influence the success of digital transformation in schools.

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METHODS

Research Design

This study employed a quantitative associative design with an **e**xplanatory survey approach to examine the influence of digital planning capability, utilization of digital infrastructure, teacher acceptance of digital aspects, and principals' risk-taking courage on school effectiveness. Data were collected through structured questionnaires and analyzed using PLS-SEM to evaluate the relationships among variables. This design enabled a systematic and empirical assessment of factors affecting school effectiveness in the context of digital transformation in West Java schools.

Participants

The participants in this study were 177 school principals from various education levels in West Java Province. The respondents were selected using random sampling to ensure representation across different school types (Figure 1) and regions (table 1). Their participation was essential, considering that principals hold strategic roles in school management, decision-making processes, and digital transformation initiatives (Figure 2).

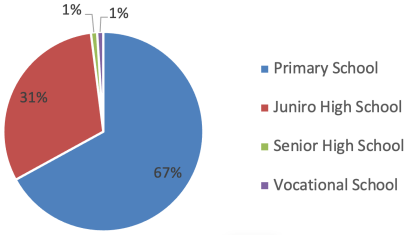

Figure 1. School Level

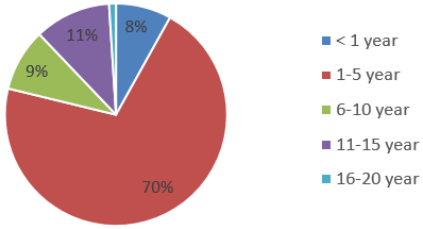

Figure 2. Length of Service as Principal

Table 1. City/Regency of Origin

School Level	City/Origin	Percentage
Primary School	Sumedang	63%
	Purwakarta	15%
	Bogor	7%
	Bandung	8%
	Tasikmalaya	2%
	Bandung Barat	1%
	Kuningan	1%
	Cirebon	1%
	Majalengka	1%
	Ciamis	1%
Junior High School	Bogor	58%
	Sumedang	30%
	Majalengka	6%
	Subang	6%
Senior High School	Pangandaran	50%
	Bogor	50%
Vocational School	Bandung	100%

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The majority of respondents were from the elementary school level, indicating a significant representation of elementary school principals in this study. Junior high school (SMP) levels were also significantly represented, followed by vocational high schools (SMK) and senior high schools (SMA), although in smaller numbers. This indicates that the research targeted the primary to secondary education sector. In terms of location, Sumedang Regency was the region of origin for the most respondents, followed by Bogor, Purwakarta, Majalengka, and Bandung Regencies. This indicates that the geographic scope of this research is relatively strong in West Java, particularly the central and western parts.

Data Collecting Procedure

Data were collected through a structured online survey distributed to school principals across West Java. The questionnaire included demographic information and measures of digital planning capability, digital infrastructure utilization, teacher digital acceptance, principals' risk-taking behavior, and school effectiveness, all assessed using a Likert-scale format. The instrument was reviewed by experts and pilot-tested prior to data collection to ensure validity and reliability. Responses were collected anonymously and analyzed using SmartPLS to assess the measurement model (validity and reliability) and the structural model (hypothesized relationships among constructs).

Table 2. The Abbreviations for Data Processing

Abbreviation	Meaning
SE	School Effectiveness
ADAT	Teachers' Acceptance of Digital Aspects
CTR	Principals' Courage to Take Risks
PDPC	Principal Digital Planning Capabilities
UDFI	Utilization of Digital Infrastructure

Instrument

Data were collected through a validated online questionnaire distributed to school principals in West Java. The survey measured demographic characteristics and key study variables using a Likert scale, and the responses were analyzed with SmartPLS to assess the measurement and structural models.

Table 3. Aspect and Indicator

Aspect	Indicator
Principal Digital Planning Capabilities (Variable X1)	I am able to develop a school work plan with the help of digital technology
	I use digital applications in budget and program planning
	I process digital data to prioritize school activities
	I am able to integrate digital platforms into managerial processes
	I regularly access digital information to support school planning

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DOI: 10.51454/jet.v7i2.932

	I am able to conduct needs analyses based on digital data
	I direct teachers to participate in the digital planning process
	I understand government policies regarding digital transformation in schools
Utilization of Digital Infrastructure (Variable X2)	The school has adequate ICT facilities to support learning
	Teachers actively use digital tools in teaching
	Internet network infrastructure supports school activities
	Digital assets (projectors, computers, smart TVs) are optimally utilized
	Digital tools are used in school administration services
	The school provides maintenance and updates for digital devices
	The school provides ICT training for teachers and staff
	Digital tools support increased work productivity among school staff
Teachers' Acceptance of Digital Aspects (Variable X3)	Teachers at this school have a positive attitude towards the use of digital technology
	Teachers are willing to participate in training related to digital learning
	Teachers are open to digital innovation in the teaching process
	Teachers utilize digital platforms for collaboration among teachers
	Teachers feel comfortable using technology in the learning process
	Teachers recognize the importance of using technology to improve quality
	Teachers are able to adapt to updates to the school's digital system
	Teachers demonstrate initiative in trying new digital devices
Principals' Courage to Take Risks (Variable X4)	I am willing to try new, technology-based approaches to leadership
	I am not afraid to make decisions, even if they haven't been tried by many other schools
	I support digital programs, despite initial limitations
	I encourage teachers to step out of their comfort zones through digital innovation
	I recognize the risks of innovation, but I choose to try anyway
	I am willing to face the technical challenges of implementing digitalization
	I encourage a culture of experimentation and reflection in the school environment
	I take responsibility for the risks of the digital decisions I make
	Our school achieves learning targets every academic year
	Parental satisfaction with educational services is high

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School Effectiveness (Variable Y)	The learning process is effective, both online and offline
	Students demonstrate optimal learning outcomes according to standards
	School programs are running according to initial planning
	The school environment supports a conducive learning culture
	Teacher performance evaluations are conducted regularly and are data-based
	Our school is known for its good and transparent governance

Data Analysis

Data in this study were analyzed using SmartPLS, a Java-based software for Partial Least Squares Structural Equation Modeling (PLS-SEM). This method is suitable for complex models, small sample sizes, and non-normally distributed data. The analysis was conducted in two stages: measurement model evaluation (validity and reliability testing) and structural model evaluation (hypothesis testing using path coefficients, R^2, Q^2, and f^2). Due to its flexibility, SmartPLS is widely used in management, education, technology, and social science research (Hair & Alamer, 2022; Iba & Wardhana, 2024; Ringle et al., 2015; Yarsasi et al., 2025).

SmartPLS version 4.1.1.4 was used to evaluate the measurement model (outer model), the structural model (inner model), and hypothesis testing (outer model), structural model (inner model), and hypothesis testing. Principal's digital planning capability, the utilization of digital infrastructure, teachers' acceptance of digital aspects, and principals' risk-taking courage are considered important factors influencing school effectiveness. Digital planning capability enables principals to formulate strategic visions and technology-based programs that support learning, school management, and teacher performance. Previous studies have demonstrated that digital leadership contributes significantly to educational effectiveness and the success of digital learning initiatives. Likewise, the utilization of digital infrastructure, including ICT facilities, internet connectivity, and digital learning media, has been shown to improve learning quality, student participation, motivation, and academic outcomes. Supported by adequate leadership, teacher training, and technical maintenance, digital infrastructure can become a key driver of school effectiveness. Therefore, it is hypothesized that principal digital planning capability (H1) and digital infrastructure utilization (H2) have positive and significant effects on school effectiveness.

In addition, teachers' acceptance of digital technology and principals' willingness to take strategic risks are also expected to contribute positively to school effectiveness. Teachers who perceive digital technologies as useful and easy to use are more likely to integrate them into teaching and learning processes, thereby enhancing instructional quality, student engagement, and overall educational outcomes. Studies based on the Technology Acceptance Model (TAM) consistently support the positive relationship between teachers' digital acceptance and educational effectiveness. Furthermore, principals who demonstrate entrepreneurial leadership characteristics, particularly the courage to take calculated risks, tend to foster innovation, adaptability, and organizational

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performance within schools. Such leadership behaviors encourage schools to respond effectively to challenges and opportunities in the digital era. Accordingly, it is hypothesized that teachers' digital acceptance (H3) and principals' risk-taking courage (H4) have positive and significant effects on school effectiveness.

RESULT AND DISCUSSION

Measurement Model (Outer Model)

A measurement model is a model that describes the relationship between a latent construct and its indicators. Outer model evaluation is conducted to test the construct's validity and reliability. This measurement model evaluation involves several testing stages, including Convergent validity testing was conducted to evaluate the extent to which indicators within the same latent construct are strongly correlated and consistently measure the intended concept. In the PLS-SEM approach, convergent validity is assessed using two main criteria, namely outer loading and Average Variance Extracted (AVE). The outer loading value reflects the strength of the relationship between an indicator and its latent variable, where values of 0.70 or higher indicate good validity. Indicators with loading values between 0.40 and 0.70 may still be retained if the AVE value of the construct remains above the acceptable threshold, whereas indicators with loading values below 0.40 should be removed due to their weak contribution to the construct. In addition, AVE measures the proportion of variance in the indicators that can be explained by the latent variable. An AVE value greater than 0.50 indicates that the construct explains more than half of the variance of its indicators, thereby demonstrating adequate convergent validity. Therefore, a construct is considered to have satisfactory convergent validity when its indicators exhibit sufficiently high outer loading values and the AVE exceeds 0.50. The results of the convergent validity test are as follows:

Table 4. Convergent Validity Test

Outer Loading Value					
	(X1) Principal Digital Planning Capabilities	**(X2) Utilization of Digital Infrastructure**	**(X3) Teachers' Acceptance of Digital Aspects**	**(X4) Principals' Courage to Take Risks**	**(Y) School Effectiveness**
SE.1					0.737
SE.2					0.720
SE.3					0.780
SE.4					0.812
SE.5					0.838
SE.6					0.722
SE.7					0.773
SE.8					0.761
ADAT.1			0.792		
ADAT.2			0.820		
ADAT.3			0.831		
ADAT.4			0.787		
ADAT.5			0.798		
ADAT.6			0.759		

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Outer Loading Value					
	(X1) Principal Digital Planning Capabilities	(X2) Utilization of Digital Infrastructure	(X3) Teachers' Acceptance of Digital Aspects	(X4) Principals' Courage to Take Risks	(Y) School Effectiveness
ADAT.7			0.813		
ADAT.8			0.792		
CTR.1				0.795	
CTR.2				0.772	
CTR.3				0.814	
CTR.4				0.674	
CTR.5				0.815	
CTR.6				0.850	
CTR.7				0.813	
CTR.8				0.792	
PDPC.1	0.680				
PDPC.2	0.706				
PDPC.3	0.891				
PDPC.4	0.866				
PDPC.5	0.779				
PDPC.6	0.842				
PDPC.7	0.803				
PDPC.8	0.802				
UDFI.1		0.640			
UDFI.2		0.729			
UDFI.3		0.603			
UDFI.4		0.811			
UDFI.5		0.793			
UDFI.6		0.692			
UDFI.7		0.666			
UDFI.8		0.727			

The results show that several indicators have outer loading values below the recommended threshold of 0.70, namely PDPC.1 (X1), UDFI.1, UDFI.3, UDFI.6, and UDFI.7 (X2), as well as CTR.4 (X4). Nevertheless, all corresponding constructs have AVE values above 0.50, indicating that convergent validity is still acceptable and the constructs adequately explain the variance of their indicators. However, the AVE value for each of these variables is >0.50. This is shown in the following table.

Table 5. AVE Value

Variable	Average variance extracted (AVE) value
Principal Digital Planning Capabilities	0.639
Utilization of Digital Infrastructure	0.505
Teachers' Acceptance of Digital Aspects	0.639
Principals' Courage to Take Risks	0.628
School Effectiveness	0.591

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DOI: 10.51454/jet.v7i2.932

Based on this table, Hair et al. (2022) considers the following rules of thumb An indicator is considered to demonstrate good convergent validity when its outer loading is at least 0.70, while indicators with loadings between 0.40 and 0.70 may still be retained if the construct's AVE remains above 0.50. In contrast, indicators with outer loadings below 0.40 should be removed because they contribute very little to representing the underlying construct. Therefore, all items in the variables in this study can be retained, as they meet the required criteria.

Discriminant Validity Test

Discriminant validity tests indicate the extent to which a construct is truly distinct from other constructs empirically; that is, the construct captures concepts not represented by other constructs in the model. Discriminant validity can be tested using the Heterotrait-Monotrait Ratio (HTMT) method. An HTMT value <0.90 indicates discriminant validity. The HTMT values are as follows:

Table 6. Discriminant Validity Test

	(X1) Principal Digital Planning Capabilities	(X2) Utilization of Digital Infrastructure	(X3) Teachers' Acceptance of Digital Aspects	(X4) Principals' Courage to Take Risks	(Y) School Effectiveness
(X1) Principal Digital Planning Capabilities					
(X2) Utilization of Digital Infrastructure	0.630				
(X3) Teachers' Acceptance of Digital Aspects	0.734	0.790			
(X4) Principals' Courage to Take Risks	0.744	0.669	0.739		

Based on the HTMT analysis, all correlation coefficients between constructs range from 0.630 to 0.790. The highest HTMT value is observed between the Utilization of Digital Infrastructure (X2) and the Teachers' Acceptance of Digital Aspects (X3) at 0.790, while the lowest is between the Principal's Digital Planning Capability (X1) and the Utilization of Digital Infrastructure (X2) at 0.630. Since all HTMT values are below the recommended threshold of 0.85, the results indicate that each construct is empirically distinct from the others, thereby confirming satisfactory discriminant validity of the measurement model. Thus, all HTMT values between variables in the model are below the threshold of 0.90, indicating that there are no discriminant validity issues between constructs. This means that each variable in this study has distinct conceptual clarity and does not statistically overlap. Therefore, it can be concluded that the constructs in this model have met the discriminant validity criteria based on the HTMT approach.

Construct Reliability Test

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Construct reliability testing is used to assess the internal consistency of indicators in measuring a construct or latent variable. In other words, this test aims to ensure that all indicators within a construct provide stable and reliable results in measuring the intended concept. Construct reliability testing is conducted using two main measures: Composite Reliability (CR) and Cronbach's Alpha. A value above 0.70 indicates adequate reliability. The reliability of the measurement model was assessed using Composite Reliability and Cronbach's Alpha. The results showed that all constructs demonstrated high levels of internal consistency and reliability. The Composite Reliability values were 0.933 for Principal's Digital Planning Capability (X1), 0.890 for Utilization of Digital Infrastructure (X2), 0.934 for Teachers' Acceptance of Digital Aspects (X3), 0.931 for Principals' Courage to Take Risks (X4), and 0.920 for School Effectiveness (Y). Similarly, the Cronbach's Alpha values were 0.918, 0.860, 0.919, 0.915, and 0.901 for X1, X2, X3, X4, and Y, respectively. Since all Composite Reliability and Cronbach's Alpha values exceed the recommended threshold of 0.70, it can be concluded that each construct possesses satisfactory reliability, indicating that the indicators consistently measure their respective latent variables and that the measurement model is reliable for further analysis.

Multicollinearity Test

The multicollinearity test is used to determine whether there is a high correlation between independent variables in the model. High multicollinearity can lead to large errors and unstable estimates. The multicollinearity test on the outer model aims to determine whether the indicators measuring a single latent construct (variable) experience multicollinearity. Based on the criteria of Hair & Alamer (2022), a VIF value <5 indicates no high multicollinearity. A VIF value between 5 and 10 is still tolerable under certain conditions but still requires critical review. Meanwhile, a value >10 is classified as severe multicollinearity and must be addressed, one way of which is by removing the indicator. The results of the outer model multicollinearity test are as follows.

Table 7. Multicollinearity Test

EFS	VIF	KAD	VIF	KMR	VIF	KPD	VIF
EFS.1	1.76	KAD.1	2.213	KMR.1	2.091	KPD.1	1.687
EFS.2	1.757	KAD.2	2.97	KMR.2	2.003	KPD.2	1.82
EFS.3	2.042	KAD.3	3.055	KMR.3	2.328	KPD.3	3.771
EFS.4	2.519	KAD.4	2.188	KMR.4	1.624		
EFS.5	2.969	KAD.5	2.495	KMR.5	2.555		
EFS.6	2.049	KAD.6	2.175	KMR.6	2.982		
EFS.7	2.008	KAD.7	2.894	KMR.7	2.493		
EFS.8	1.972	KAD.8	2.685	KMR.8	2.192		

Based on the table above, the results of the Variance Inflation Factor (VIF) test in the outer model indicate that all indicators have VIF values below the required threshold. This indicates that there are no symptoms of multicollinearity

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among the indicators within each construct. Therefore, the measurement model (outer model) is declared to meet the multicollinearity test criteria.

Structural Model (Inner Model)

A structural model (inner model) is a model that describes the relationship between latent variables (constructs) in a research model. Evaluation of the inner model is carried out by testing:

Multicollinearity Test

The inner model multicollinearity test aims to determine whether exogenous latent variables (constructs) are too highly correlated when explaining endogenous variables. Based on the criteria of Hair & Alamer (2022), a VIF value <5 indicates no high multicollinearity. A VIF between 5 and 10 is still tolerable under certain conditions but still requires critical review. Meanwhile, a value >10 is classified as severe multicollinearity and must be addressed, one way of which is by removing the indicator. The VIF value of each variable obtained an X1 value of 2.283, an X2 value of 2.197, an X3 value of 2.836, and an X4 value of 2.421. This shows that the VIF value of each variable against Y (school effectiveness) is <5.0. Therefore, the variable does not have symptoms of multicollinearity and can be used in further analysis.

Coefficient of Determination (R^2)

To demonstrate the extent to which the independent (exogenous) variable is able to explain the dependent (endogenous) variable in a structural model. An R^2 value of ≥ 0.75 is interpreted as strong, an R^2 value of 0.50–0.74 is moderate, an R^2 value of 0.25–0.49 is weak, and an R^2 value <0.25 is very weak. The R2 test value obtained a value of 0.601. Based on this value, it has a moderate accuracy estimate. In other words, Variable X1 (School Principal's Digital Planning Capability), Variable X2 (Utilization of Digital Infrastructure), Variable X3 (Teachers' Acceptance of Digital Aspects), and Variable X4 (Principals' Courage to Take Risks) simultaneously influence Variable Y (School Effectiveness) by 60.1% and the remaining 39.9% is influenced by other factors.

Effect size test (f^2)

The effect size (f^2) analysis reveals that the contribution of each exogenous construct to School Effectiveness is generally small. Principal's Digital Planning Capability ($f^2 = 0.039$) and Teacher Acceptance of Digital Aspects ($f^2 = 0.061$) exert small effects on School Effectiveness. The Utilization of Digital Infrastructure exhibits a negligible effect ($f^2 = 0.010$), as its value falls below the recommended threshold of 0.02. Principals' Courage to Take Risks demonstrates the highest effect size ($f^2 = 0.118$); however, this value remains within the small effect category. These findings indicate that, although several predictors significantly influence School Effectiveness, their individual contributions are relatively modest, suggesting that other factors outside the model may also play important roles in explaining variations in School Effectiveness.

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DOI: 10.51454/jet.v7i2.932

Predictive Relevance Test (Q^2)

To measure the predictive ability of the model on the dependent variable. According to Hair & Alamer (2022) the Q^2 criterion is if $Q^2 > 0$, it means the model has good predictive power; if $Q^2 < 0$ means the model has no predictive power. The interpretation of a Q^2 value > 0.35 is strong predictive, a Q^2 value of 0.15 – 0.34 is moderate predictive, a Q^2 value of 0.02 – 0.14 is weak predictive and a Q^2 value ≤ 0 means there is no predictive relevance. The results of the Q^2 test are as follows.

Table 8. Predictive Relevance Test (Q^2)

Variable	Q^2predict	Category
Principals' Digital Planning Capabilities, Utilization of Digital Infrastructure, Teachers' Acceptance of Digital Aspects, and Principals' Courage to Take Risks → School Effectiveness	0.569	Strong

Based on the test results in the table above, it can be obtained that the Q2 test value obtained a value of 0.569, indicating that the model has strong predictive relevance power.

Goodness of Fit Test

To assess the extent to which the overall structural and measurement models constructed fit the empirical data obtained from the field. PLS-SEM does focus on prediction, but model fit remains important (Hair & Alamer, 2022). In PLS-SEM, a model is declared to have a good statistical fit if the SRMR (Standardized Root Mean Square Residual) value is ≤ 0.08. Substantial fit is determined by looking at the R^2 (R-Square), f^2 (effect size), and Q^2 (Predictive Relevance) values, as well as the magnitude and significance of the paths between constructs. The SRMR value is 0.074, indicating that the model value is below the recommended maximum limit, which is ≤ 0.08. Thus, the model is stated to have a good fit statistically. This indicates that the difference between the observed data and the data estimated by the model is small, so the model fits the data.

Hypothesis Testing

Hypothesis testing in SmartPLS is conducted using path analysis through bootstrapping techniques, to determine the magnitude of influence and significance of the relationship between latent variables (constructs). Tested by reviewing the original sample values and p-values. The path coefficient in the structural model not only shows the magnitude of influence but also determines the direction of the relationship between constructs. According to Hair & Alamer (2022), the sign of the path coefficient determines the direction of the relationship between latent variables, where a positive value indicates a unidirectional relationship and a negative value indicates an inverse relationship. According to Hair & Alamer (2022), the significance criterion if the p-value ≤ 0.05 means a significant relationship, while if the p-value > 0.05 means the relationship is insignificant. The results of the path coefficient diagram are as follows.

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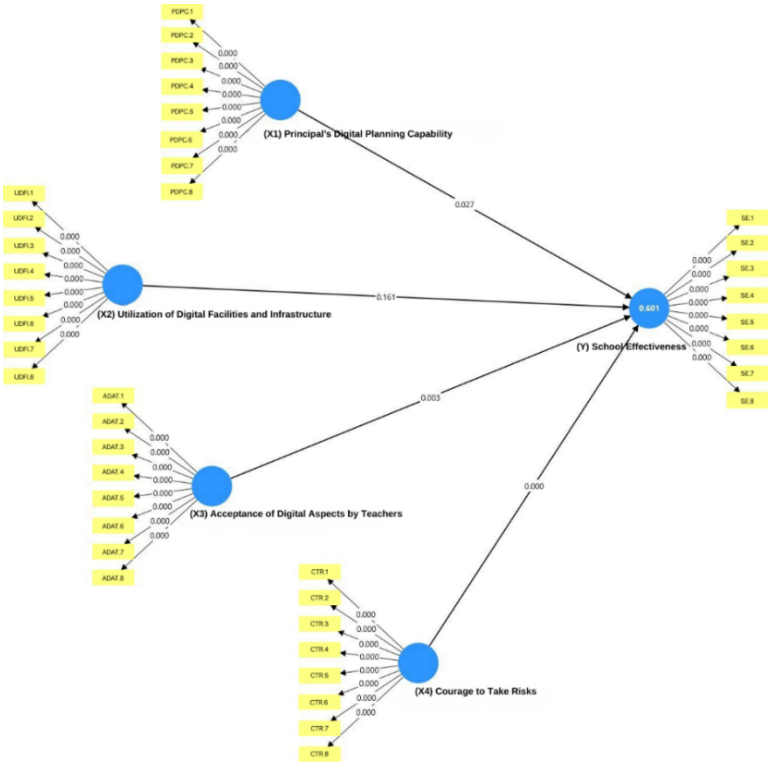

Figure 3. Hypothesis Testing

The hypothesis testing results show that three of the four proposed hypotheses were supported. Principal Digital Planning Capability (H1), Utilization of Digital Infrastructure (H2), Teacher Acceptance of Digital Aspects (H3), and Principals' Courage to Take Risks (H4) each have a positive and significant effect on School Effectiveness, as indicated by positive path coefficients and p-values ≤ 0.05. These findings suggest that school effectiveness can be enhanced through strong digital leadership, effective utilization of digital infrastructure, positive teacher attitudes toward technology, and principals' willingness to take strategic risks. The results are consistent with previous studies highlighting the importance of digital transformation and innovative leadership in improving educational outcomes.

The image above shows the results of the research model hypothesis test, as seen from the bootstrapping results. Furthermore, the results of the structural model path coefficients can be clearly seen in the following table.

Table 9. Structural Model Path Coefficients

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P-values	Information
Principal Digital Planning Capabilities → School Effectiveness	0.188	0.187	0.085	2.215	0.027	Accepted
Utilization of Digital Infrastructure → School Effectiveness	0.095	0.104	0.067	1.403	0.161	Rejected

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DOI: 10.51454/jet.v7i2.932

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P-values	Information
Teachers' Acceptance of Digital Aspects → School Effectiveness	0.262	0.262	0.088	2.990	0.003	Accepted
Principals' Courage to Take Risks → School Effectiveness	0.338	0.337	0.085	3.965	0.000	Accepted

Based on the hypothesis testing results, three of the four proposed hypotheses are supported. Principal's Digital Planning Capability (X1) has a positive and significant effect on School Effectiveness (O = 0.188; p = 0.027), indicating that stronger digital planning by school leaders contributes to improved school effectiveness. Likewise, Teacher Acceptance of Digital Aspects (X3) positively and significantly influences School Effectiveness (O = 0.262; p = 0.003), suggesting that teachers' willingness to adopt and utilize digital technologies enhances educational performance. Principals' Courage to Take Risks (X4) also demonstrates a positive and significant effect (O = 0.338; p = 0.000), highlighting the importance of innovative and risk-tolerant leadership in improving school effectiveness. In contrast, the Utilization of Digital Infrastructure (X2) shows a positive but statistically insignificant effect on School Effectiveness (O = 0.095; p = 0.161). This finding suggests that the mere availability and use of digital facilities and infrastructure are insufficient to significantly improve school effectiveness unless they are accompanied by effective leadership, teacher readiness, and supportive organizational practices.

Discussion

The results of the measurement model testing in this study indicate that the indicators used generally represent the latent constructs well. This means that each indicator is able to explain the concept being measured consistently and relevantly. This is reflected in the factor loading values, which, although not all high, remain within acceptable limits for structural equation modeling-based research. Some indicators did show suboptimal measurement values, indicating the possibility that some indicators did not fully capture the essence of the construct or that external variables still influenced respondents' responses. Nevertheless, overall, convergent validity was met, as evidenced by the average variance extracted (AVE) value that met the criteria. This finding provides a strong basis that the measurement instrument used in this study is theoretically and empirically appropriate and is able to accurately describe the relationship between the construct and its indicators. Good convergent validity also indicates that the variables in the study have a sufficiently high level of internal coherence, allowing interpretation of the results with confidence that the measurement model has performed well.

The principal's digital planning capability demonstrates a stable and consistent indicator structure, indicating that this construct has been well-

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measured through the instruments used. The stability of the indicators reflects the alignment between the theoretical concept of digital planning capability and the reality on the ground, particularly in the context of school leadership. Principals with this capability are able to design strategic plans based on digital technology that are not only administrative in nature but also transformative in driving the performance of all school elements. They tend to have a long-term perspective, are able to identify the school's digitalization needs, and establish development priorities that align with the educational institution's vision and mission. This digital planning encompasses the use of data in decision-making, management of school information systems, and the integration of technology into learning. Therefore, this capability is a crucial element in realizing adaptive, responsive school governance that is oriented toward improving the quality of education. Principals with strong digital planning capabilities are also better prepared to face the challenges of the digital era, such as technology-based curriculum changes, the need for teacher training in digital literacy, and increasing demands for transparency and accountability from the community.

Meanwhile, other research suggests that the role of the principal is crucial in digital leadership. Leadership strategies should focus on facilitating the development of a school culture that supports innovation, continuous learning, and collaboration. Principals should be agents of change who promote the benefits of ICT, design capacity-building programs, engage stakeholders, and systematically evaluate implementation progress (Amar & Eleyan, 2022; Gil-Flores et al., 2024; Makrakis, 2024; Suwarto et al., 2022; Xu & Zhu, 2023; Yusmiati et al., 2025)

Although the utilization of digital infrastructure in this study showed several indicators with relatively lower measurement strength compared to other constructs, overall, they still met the required validity criteria. This means that the instrument used was still able to adequately represent the concept of digital facility utilization in the school environment. This finding can be interpreted as indicating that physically, most schools already have digital infrastructure such as computers, internet connections, projectors, and online learning management platforms. However, the level of utilization is still suboptimal. The low strength of some indicators may reflect a gap between availability and utilization. In practice, some of these digital facilities may not be used consistently in learning and management activities, either due to limited human resource competency, low motivation to use technology, or the lack of integration of digital technology into the school's daily work system. Furthermore, policy factors, technical support, and organizational culture can also influence the extent to which digital infrastructure is actually utilized. Therefore, these results signal the need to increase the capacity of teachers and education personnel to optimize the use of available digital facilities, as well as the important role of school principals in ensuring that investments in digital facilities truly impact the effectiveness of learning and school governance.

Regarding digital infrastructure, research shows that digital infrastructure within organizations has evolved rapidly along with technological developments.

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This transformation is not simply the adoption of new technology but involves a comprehensive restructuring of organizational operations and culture. Digital infrastructure encompasses not only physical hardware and software but also the policies, procedures, and culture that govern how these devices should be used (Haryanti et al., 2023; Saeedikiya et al., 2024; Tian & Lu, 2023). Robust, reliable, and user-friendly digital infrastructure can boost user perceptions of digital devices, resulting in greater digital literacy, higher productivity, and greater innovation (Lee et al., 2022; Matli & Wamba, 2023).

Indicators of teachers' acceptance of digital aspects show high consistency, indicating that this construct has been well-measured and can be relied upon to explain teachers' attitudes and behaviors toward digital technology. This consistency reflects a relatively uniform level of acceptance among respondents, meaning that most teachers have accepted the presence of digital technology as part of their professional practice. This indicates that the process of internalizing the importance of digitalization in education is well underway. Teachers are not simply using technology because of policy demands but are beginning to understand its benefits in improving the quality of learning, accelerating administrative processes, and expanding access to learning resources.

Research indicates that digital transformation is a teacher strategy for creating higher-quality, enjoyable, meaningful, creative, and effective classroom learning management. The implementation of digital transformation-based teacher learning management can explore student skills (Nurdin et al., 2023). One of the challenges to teacher professionalism is the ability to teach based on digital competencies, which teachers must possess and integrate into their professional practice (García-Ruiz et al., 2023; Garzón-Artacho et al., 2021).

This acceptance also indicates a willingness to continue learning and adapting to changes brought about by digital transformation, such as the use of Learning Management Systems (LMS), online assessment applications, and internet-based communication platforms. Furthermore, acceptance of digital aspects indicates a paradigm shift in education, moving from conventional approaches to a more flexible, interactive learning system oriented toward 21st-century skills. This success is certainly inseparable from the support of school policies, ongoing training, and a work environment that encourages collaboration and technological exploration. Therefore, teacher acceptance of digital aspects is a crucial foundation for strengthening technology integration throughout the education system and serves as an indicator of school readiness to face the challenges of future digital transformation (Bond et al., 2018; Chorosova et al., 2020; Junindra et al., 2021; Saputro et al., 2021).

Principals' risk-taking courage demonstrates strong and reliable indicators, indicating that this construct has been consistently identified across various measurement dimensions in the study. These findings demonstrate that principals, as educational leaders, have demonstrated a readiness to step outside their comfort zones, particularly in the context of implementing digital-based policies and innovations. Risk-taking courage not only reflects personal traits but also demonstrates a proactive leadership vision that is responsive to the

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challenges of the times. Principals who are willing to take risks typically do not hesitate to initiate change, try new approaches, or implement unproven technologies, as long as they believe these steps will add value to the school's effectiveness.

Furthermore, this courage reflects the principal's ability to manage uncertainty and transform it into opportunities. In the context of digital transformation, this can be seen in the courage to make decisions about allocating funds to school information systems, developing policies for the use of technology in learning, or encouraging teachers and staff to adopt digital tools despite initial resistance. Principals who display this kind of courage also tend to be role models in building a culture of innovation and continuous learning within the school environment. Thus, the Principals' Courage to Take Risks not only contributes to the successful implementation of digitalization but also strengthens the strategic leadership character needed to create adaptive, progressive, and superior schools in the digital era. This means that the principal is a crucial factor in school success, where principal competence is a key indicator of educational quality. Furthermore, the principal must act as a manager who carries out management functions, including planning (Juhji, 2020; Umar et al., 2025).

School effectiveness, as the outcome variable, is concretely measurable through dimensions such as learning quality, improved teacher and student performance, governance efficiency, and school community satisfaction, indicating that it is not merely an abstract concept. In the context of digital transformation, technology functions not only as a tool but as a strategic driver of systemic change in education management, fostering adaptive, innovative, and responsive school environments. Effective schools are characterized by high academic achievement and positive disciplinary behavior among both students and staff, supported by strong leadership, collaborative culture, and strategic use of digital resources to enhance instructional quality, organizational efficiency, and community engagement (Alagbela & Bayuo, 2024; Bishara, 2018; Javornik & Mirazchiyski, 2023; Syahputra et al., 2024).

Furthermore, the success of representing school effectiveness through solid indicators confirms that digital transformation, designed and implemented with a well-thought-out strategy, will have a direct impact on improving overall institutional performance. Indicators such as the achievement of learning objectives, the implementation of a relevant and adaptive curriculum, and increased parental and community involvement are concrete evidence that digitalization has a positive impact on the school climate and culture. In this context, school effectiveness is not only measured by academic output but also by how the school system is able to adapt, innovate, and provide quality education services sustainably.

School effectiveness is defined as the extent to which the educational, organizational, and administrative goals of the school are achieved. School effectiveness is generally related to its efficiency and educational orientation (Chatzipanagiotou & Katsarou, 2023; Ergin et al., 2021). Therefore, these findings reinforce the importance of digital leadership, infrastructure readiness, teacher

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acceptance of technology, and Principals' Courage to Take Risks as determining factors in strengthening the effectiveness of educational institutions in the digital era.

The absence of overlap between constructs, such as principals' digital planning capabilities, digital infrastructure utilization, teachers' digital acceptance, risk-taking, and school effectiveness, provides a strong foundation for interpreting the analysis results. This allows researchers to more accurately assess the contribution of each variable and avoid drawing vague or biased causal conclusions. Furthermore, strong discriminant validity strengthens the overall validity of the conceptual model, ensuring reliable recommendations for educational policymaking, particularly in digital transformation efforts within schools. Overall, these findings demonstrate that the research design has maintained the theoretical and empirical integrity of the constructs studied, a crucial prerequisite for generating meaningful and applicable knowledge.

Structurally, the model developed in this study has proven to be able to explain the relationships between variables well, indicating that the theoretical framework used is consistent with the empirical data. The relationship between the principal's digital planning capabilities, the use of digital infrastructure, teachers' acceptance of digital aspects, and their willingness to take risks shows a coherent and complementary pattern of contributions in explaining school effectiveness as an outcome variable. These four variables, both individually and collectively, have a significant impact on school quality and performance in the digital era. This confirms that digital transformation in the education ecosystem depends not only on the availability of technology but also on the readiness of key actors in the school ecosystem to manage these changes strategically and adaptively.

Thus, this model is not only theoretically relevant but also has high predictive power for application in the context of educational policy and institutional development. Its success in explaining the relationships between variables without the interference of multicollinearity strengthens this model's position as a reliable analytical tool for evaluating and designing more effective and sustainable school digital transformation strategies.

A key finding from this analysis indicates that teachers' risk-taking and digital acceptance factors contribute more strongly to school effectiveness than the other two variables, namely the principal's digital planning capabilities and the utilization of digital infrastructure. These results reflect that the success of digital transformation in a school environment is not solely determined by strategic planning or the availability of digital infrastructure, but rather depends more on the attitudes and behaviors of individuals at the forefront of change, namely the principal as the policy driver and teachers as the main implementers in the classroom.

Principals' Courage to Take Risks is key in a school's digital transformation process because it reflects a principal's readiness to step out of their comfort zone, make innovative strategic decisions, and face uncertainty in adopting new technologies. Principals who are bold enough to try different approaches and are

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open to technological experimentation tend to be more adaptive to the dynamics of changing times. They not only implement digital policies administratively but also create an innovative culture within the school that encourages the active participation of all school members in the change process. Initiatives such as developing an internal learning platform, encouraging digital collaboration between teachers, or integrating technology into assessments are concrete examples of courage that have a direct impact on improving school effectiveness.

From the perspective of the Technology Acceptance Model (TAM), principals' digital planning capability not only reflects their technical and managerial competencies but also plays a crucial role in shaping users' perceived usefulness and perceived ease of use of technology within the school environment. When principals are able to formulate a clear digital vision, allocate resources effectively, and integrate technology into the school's strategic planning, teachers and educational staff are more likely to demonstrate higher levels of technology acceptance. Therefore, the stability of the indicators within the digital planning capability construct suggests that principals possess the capacity to act as change agents who systematically promote technology adoption. This finding is consistent with the study by Susanto et al. (2025), which revealed that digital leadership capability significantly influences perceptions of usefulness and ease of use of digital systems, ultimately enhancing the sustainability of technology utilization in educational settings. Furthermore, strong digital leadership contributes to school effectiveness by fostering a culture of technology use and data-driven decision-making (Okunlola, 2025).

From the perspective of the Diffusion of Innovations (DOI) Theory, principals' digital planning capability can be viewed as a critical factor in accelerating the diffusion of innovation within schools. Rogers argued that the success of innovation adoption is largely influenced by leaders' ability to communicate the benefits of innovation, reduce uncertainty, and create an environment that supports change. Principals with strong digital planning capabilities are better positioned to identify technological needs, establish priorities for digital transformation, and develop communication mechanisms that encourage teachers to become early adopters. In this context, the stability of the construct observed in this study indicates that digital planning is not merely an administrative activity but a strategic instrument for expanding innovation adoption throughout the school organization. This finding is supported by research on school digital transformation, which emphasizes that the success of digitalization is highly dependent on school leadership that can effectively guide the change process and build commitment among all school stakeholders toward technological innovation (Reis-Andersson, 2024; Rosyida & Sonia, 2025).

Furthermore, the findings of this study suggest that principals' digital planning capability has the potential to serve as a fundamental pillar for sustainable school transformation. However, the presence of several indicators with less-than-optimal measurement values indicates that the effectiveness of digital planning may also be influenced by other factors, such as organizational culture, technological readiness, teachers' digital competence, and external policy

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support. Therefore, future research should develop more comprehensive models by incorporating TAM and DOI constructs as mediating or moderating variables. Such an approach would provide a deeper understanding of how principals' digital planning capabilities can be translated into greater technology acceptance, accelerated innovation diffusion, and improved school effectiveness. Recent studies also indicate that digital leadership is one of the key determinants of successful school digital transformation and the enhancement of teachers' capacity to integrate technology into the teaching and learning process (Liu et al., 2025; Yang et al., 2025).

Furthermore, the finding regarding the robustness of the principal's digital planning capability construct can also be explained through the perspective of digital transformation leadership, which emphasizes the importance of a leader's ability to align strategy, technology, and human resources simultaneously. Effective digital planning enables principals to anticipate changes in an increasingly dynamic educational environment and ensure that technology investments generate tangible impacts on both teaching and learning processes as well as school management. In this context, digital planning capability functions not only as a managerial instrument but also as a mechanism for building organizational readiness for digital transformation. Research conducted by Dexter et al. (2023) demonstrated that leadership with a strategic orientation toward technology significantly influences schools' readiness to implement digital innovation in a sustainable manner. Similar findings were reported by Petko et al. (2022), who argued that the successful integration of technology in schools largely depends on leaders' capacity to establish a clear direction for digital transformation, manage organizational change, and build support among all school stakeholders.

On the other hand, the results of this study indicate that principals' digital planning capability may generate indirect effects on improving the quality of learning through the enhancement of teachers' digital competencies. When digital planning is systematically designed, schools are more likely to provide training, mentoring, and infrastructure that support the effective use of technology in instructional processes. Such conditions can increase teachers' confidence in integrating technology while accelerating the development of a culture of innovation within schools. Recent research by Scherer et al. (2021) found that school leadership that supports digital transformation is positively associated with teachers' readiness to utilize technology for teaching and learning. Likewise, Admiraal et al. (2021) reported that a strong digital vision from school leaders contributes to increased teacher collaboration, the development of digital competencies, and the successful implementation of technology-based educational innovations. Therefore, principals' digital planning capability can be regarded as a strategic factor that not only influences the managerial aspects of schools but also contributes to enhancing the overall quality of teaching and learning processes.

Overall, the findings of this study confirm that principals' digital planning capability is one of the strategic competencies that determines the success of

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digital transformation in schools. This capability not only supports technology acceptance and adoption, as explained by the Technology Acceptance Model (TAM) and the Diffusion of Innovations (DOI) Theory, but also contributes to strengthening organizational readiness, enhancing teachers' digital competencies, and fostering a sustainable culture of innovation. Through well-developed digital planning, principals can direct the use of technology more effectively to support data-driven decision-making, improve the quality of teaching and learning, and strengthen overall school effectiveness. Therefore, strengthening principals' digital planning capacity should become a priority in educational leadership development programs to ensure that school digital transformation initiatives produce meaningful and sustainable improvements in educational quality in the digital era.

CONCLUSION

Based on the evaluation of the measurement and structural models, all constructs generally met the established validity and reliability criteria, indicating that the proposed model was statistically sound for explaining school effectiveness in the context of digital transformation. The findings revealed that principals' digital planning capability, teachers' digital acceptance, and principals' risk-taking behavior positively and significantly influenced school effectiveness, with risk-taking behavior demonstrating the strongest effect among all predictor variables. In contrast, digital infrastructure utilization had a positive but insignificant effect, suggesting that the availability of technology alone is insufficient to improve school performance without effective leadership, teacher readiness, and organizational support. Overall, the results indicate that school effectiveness is driven more by human and organizational factors than by technological resources alone, highlighting the critical role of digital leadership, teacher readiness for innovation, and strategic risk-taking in achieving sustainable school improvement in the digital era.

Based on the findings of this study, which demonstrate that principals' digital planning capability, teachers' acceptance of digital aspects, and principals' willingness to take risks significantly influence school effectiveness, educational policymakers should develop structured digital leadership development programs through practice-oriented training, coaching, and performance evaluation systems that incorporate indicators of innovation and digital transformation. At the school level, principals should foster an organizational culture that supports experimentation, continuous learning, and collaboration by establishing digital learning communities, providing opportunities for teachers to implement technology-based instructional innovations, and recognizing successful initiatives and best practices. In addition, schools should create a supportive environment for calculated risk-taking, where failures arising from innovation efforts are viewed as learning opportunities rather than mistakes to be punished. Furthermore, digital infrastructure support should be integrated with teacher capacity-building programs, technical assistance, and school policies that encourage the effective

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use of technology, ensuring that investments in digitalization generate tangible improvements in school effectiveness.

ACKNOWLEDGMENT

The authors would like to express their sincere gratitude to the school principals across West Java who participated in this study and generously provided the data required for this research. The authors also acknowledge the support of the Faculty of Educational Administration, Universitas Pendidikan Indonesia, for its academic guidance and assistance throughout the research process. Taufani Chusnul Kurniatun conceptualized the study, developed the research design, collected and analyzed the data, interpreted the findings, and prepared the original manuscript draft. Li Kun Mei contributed to the literature review, methodology refinement, data interpretation, manuscript review, editing, and validation of the final version of the manuscript. Both authors have read and approved the final manuscript.

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