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The Influence of Digital Competence, IT Infrastructure, and Transformational Leadership on Digitalization Effectiveness

Noormalita Megarona[1*], Lantip Diat Prasojo[1]

[1] Master of Educational Management, Faculty of Education Science and Psychology, Universitas Negeri Yogyakarta, Sleman, Indonesia

[*] *Corresponding author: Noormalita Megarona (noormalitamegarona.2024@student.uny.ac.id)*

Abstract

The increasing use of digital technology in school administration requires educational institutions to strengthen human resource readiness, technological infrastructure, and leadership capacity to ensure effective digital management. This study analyzes how educational personnel's digital competence, information technology infrastructure, and school principals' transformational leadership affect the effectiveness of school management system digitalization in public senior high schools in Yogyakarta City. A quantitative approach with a causal-associative design was employed, involving 202 educational personnel from 11 public senior high schools selected through total sampling. Data were collected using a five-point Likert questionnaire. Data were analyzed using descriptive statistics and multiple linear regression with SPSS. Digital competence had a positive and significant effect on digitalization effectiveness ($B = 0.046$; $p = 0.021$). Information technology infrastructure also had a positive and significant effect ($B = 1.335$; $p < 0.001$), as did school principals' transformational leadership ($B = 0.085$; $p < 0.001$). Simultaneously, the three variables significantly affected digitalization effectiveness ($p < 0.001$), with an R^2 of 0.971. These findings imply that schools should integrate infrastructure improvement, job-relevant digital competence development, and transformational leadership to strengthen sustainable digital management practices.

Keywords

Digital Competence, Digitalization Effectiveness, Information Technology Infrastructure, School Principals' Transformational Leadership.

1. Introduction

Digital technology development in the era of the Industrial Revolution 4.0 and Society 5.0 has changed how educational organizations perform their managerial functions. Schools are no longer required only to provide educational services, but also to manage data, administration, finance, resources, and information quickly and accountably. Digitalizing school management systems is one strategy for strengthening governance because technology can speed up processes, improve data accuracy, and support data-driven decision-making (Sariwardani, 2024; Faizah et al., 2026).

National education policies have also encouraged the use of various digital platforms for school management, including Basic Education Data (*Data Pokok Pendidikan/Dapodik),* School Activity and Budget Planning Application (*Aplikasi Rencana Kegiatan dan Anggaran Sekolah/ARKAS),* and School Procurement Information System *(Sistem Informasi Pengadaan Sekolah/SIPLah*). These platforms show that digitalization is now part of school administration and management practices. Digitalization is not merely transferring manual work to applications; it changes work processes and requires organizational, human resource, technological, and leadership readiness (Verhoef et al., 2021; Reis-Andersson, 2024).

In this context, educational personnel are directly involved with school administrative systems and data. Digital competence is needed so that educational personnel can operate devices and applications, manage information, maintain data security, and adapt when systems are updated. Falloon (2020) defines digital competence as broader than digital literacy, while studies of school administrative staff show that technological ability supports the effective use of information systems in administrative work (Gunawan et al., 2023; Febriani et al., 2023). Beyond the human factor, information technology infrastructure provides the technical foundation for sustaining digitalization. Hardware, software, networks, connectivity, databases, security, and technical support determine whether systems can be accessed and used consistently. Unstable infrastructure can hinder data entry, processing, storage, and exchange, preventing users from fully realizing their competencies (Hu et al., 2024; Purwani et al., 2025).

Organizational factors also play an important role. Transformational leadership in schools involves leaders building a vision, inspiring school members, encouraging innovation, providing intellectual stimulation, and attending to individual needs. In the transition toward digital governance, principals are not only decision-makers but also change leaders who build commitment and an adaptive work culture (Timan et al., 2022; Dema et al., 2023; Rahayu & Iskandar, 2023). Preliminary observations in several public senior high schools in Yogyakarta City indicated variations in educational personnel's ability to operate digital systems, particularly when applications are updated. Several schools also experienced network problems, limited administrative devices, technical disruptions, and dual administrative practices involving both digital systems and manual records. Principals' support for technology use also varied, particularly in strengthening data- and technology-based work cultures. These conditions indicate that the effectiveness of school management system digitalization needs to be understood integratively. Digital competence represents the readiness of human resources as system users and managers, IT infrastructure provides the operational technical foundation, while transformational leadership directs organizational change. Reis-Andersson (2024) emphasizes that school digitalization is an organizational change process involving the interrelationship of people, technology, and leadership.

Previous studies have widely examined digital competence, infrastructure, and leadership in educational contexts. However, few studies have examined these three factors simultaneously in relation to the effectiveness of school management system

digitalization in public senior high schools in Yogyakarta City. This study aims to analyze the effects of digital competence of educational personnel, information technology infrastructure, and transformational leadership of school principals on the effectiveness of school management system digitalization, both partially and simultaneously.

2. Literature Review and Hypothesis Development

2.1. The Effect of Digital Competence of Educational Personnel

Digital competence of educational personnel reflects the capacity to use digital technologies effectively, securely, and critically in accordance with administrative responsibilities. It involves operating hardware and software, managing digital information, utilizing administrative applications, communicating through digital platforms, maintaining data security and ethical practices, and adapting to system changes (Falloon, 2020). In school organizations, digitalization encompasses not only technical adoption but also broader administrative and organizational changes across different levels of the institution (Lindqvist & Pettersson, 2019). Adequate digital competence enables educational personnel to process data, manage digital documents, operate administrative applications, prepare reports, and respond to system updates effectively (Ningsih et al., 2025). Conversely, limited competence may hinder digitalization within educational organizations (Tømte, 2024).

Digital competence enables technological resources to be transformed into practical and effective school management processes. Shah (2014) highlights the importance of personnel's capacity to manage data, information systems, and administrative services to support effective digital education administration. This argument is further supported by research showing that stronger technological capabilities contribute to more effective school administration management (Febriani et al., 2023; Darmansah et al., 2024). Beyond routine administrative tasks, the effective, strategic use of technology can foster innovation, improve decision-making, and support more efficient resource management (Nimkrathok & Boonchan, 2026). Therefore, educational personnel with adequate digital competence are better able to maximize school management systems and turn available technological resources into effective digital management practices.

H1: Digital competence of education personnel has a positive and significant effect on the effectiveness of school management system digitalization.

2.2. The Effect of Information Technology Infrastructure

Information technology infrastructure provides the technological foundation that supports the reliable, continuous operation of digital systems. It covers essential components such as hardware, software, network connectivity, databases, security systems, and related technology services and management. When these components are adequately available, users can access digital platforms, process information, and exchange data across organizational units more consistently. In educational management, appropriate infrastructure supports centralized, real-time management of student records, financial information, teacher attendance, and learning evaluations, enabling more accurate and efficient program monitoring (Suhardi & Fahmi, 2025). Adopting ICT in educational management can also improve operational efficiency, learning quality, and access to educational services (Harini et al., 2024).

The successful implementation of school management digitalization is consequently influenced by the readiness and reliability of its technological infrastructure. Yuliantari et al. (2025) found that ICT facilities, such as computer laboratories, digital classroom resources, and online administrative platforms, can

improve administrative efficiency and strengthen data transparency. However, digitalization may be disrupted when devices are insufficient, network connections are unstable, system capacity is limited, or technical assistance is inadequate. Hu et al. (2024) indicate that weaknesses in hardware, software, and network availability can obstruct digitalization in educational management. Similarly, Purwani et al. (2025) emphasize infrastructure readiness as an important element supporting effective digital governance. Therefore, reliable and sustainable infrastructure is fundamental to achieving effective digitalization of school management.

H2: Information technology infrastructure has a positive and significant effect on the effectiveness of school management system digitalization.

2.3. The Effect of Transformational Leadership of School Principals

Transformational leadership, as conceptualized by Bass and Avolio, involves idealized influence, inspirational motivation, intellectual stimulation, and individualized consideration. Through these dimensions, leaders provide direction, communicate a shared vision, encourage new perspectives, and respond to organizational members' needs. Such leadership is particularly relevant to school digitalization because technological transformation requires more than adopting new systems. It also involves guiding people through changes in work practices and organizational routines. In this context, principals play a key role in communicating a digital vision, encouraging collaboration, supporting staff, promoting effective data use, and fostering openness to innovation. Dema et al. (2023) highlight transformational leadership as a key element in developing a digital vision, managing organizational change, and involving school members in implementing digital systems.

Recent studies further demonstrate the organizational value of transformational leadership in educational digitalization. Musmuliadi et al. (2026) found that principals' transformational and democratic leadership can strengthen readiness for change, improve teachers' digital literacy, and develop an adaptive organizational culture, particularly when digitalization is managed systematically and sustainably. Transformational leadership is also associated with faster adoption of digital technologies while keeping a clearer focus on educational objectives rather than the technology itself (Ruloff & Petko, 2025). Moreover, it can foster innovation, collaboration, and organizational responsiveness, enabling schools to adapt to technological and educational changes (Timan et al., 2022; Rahayu & Iskandar, 2023; Handayani et al., 2025; Ranosa et al., 2025).

H3: Transformational leadership of school principals has a positive and significant effect on the effectiveness of school management system digitalization.

2.4. Simultaneous Effect on the Effectiveness of School Management System Digitalization

School management involves planning, organizing, implementing, directing, and controlling educational resources to achieve organizational objectives effectively and efficiently. Information technology can strengthen these functions by enabling faster, more accurate, and more transparent management of data and work processes, based on available information (Khoiri & Wulan, 2024; Solahudin et al., 2025). In this study, school management system digitalization represents the transition from manual administrative and managerial practices to integrated, information technology-based systems that cover student data, personnel, finance, facilities, correspondence, and reporting, as well as platforms such as Dapodik, ARKAS, and SIPLah. Its effectiveness is reflected in system quality, information quality, service

quality, user satisfaction, and organizational benefits based on the DeLone and McLean framework (Widyaningrum et al., 2024).

The effectiveness of such digitalization depends on integrating human, technological, and organizational capacities. Reis-Andersson (2024) frames educational digitalization as an organizational change process involving human resource competence, readiness of technological infrastructure, and leadership in managing change. Digital competence enables personnel to operate and utilize systems effectively, while adequate infrastructure provides the technical conditions required for continuous system operation. At the organizational level, transformational leadership provides direction, motivation, support, and readiness for change. Consistent with the arguments developed in H1–H3, these factors complement each other in translating digital systems into effective management practices. Therefore, combining user competence, infrastructure readiness, and transformational leadership is expected to provide stronger support for school management system digitalization than relying on any single factor independently.

H4: Digital competence of education personnel, information technology infrastructure, and transformational leadership of school principals simultaneously have a positive and significant effect on the effectiveness of school management system digitalization.

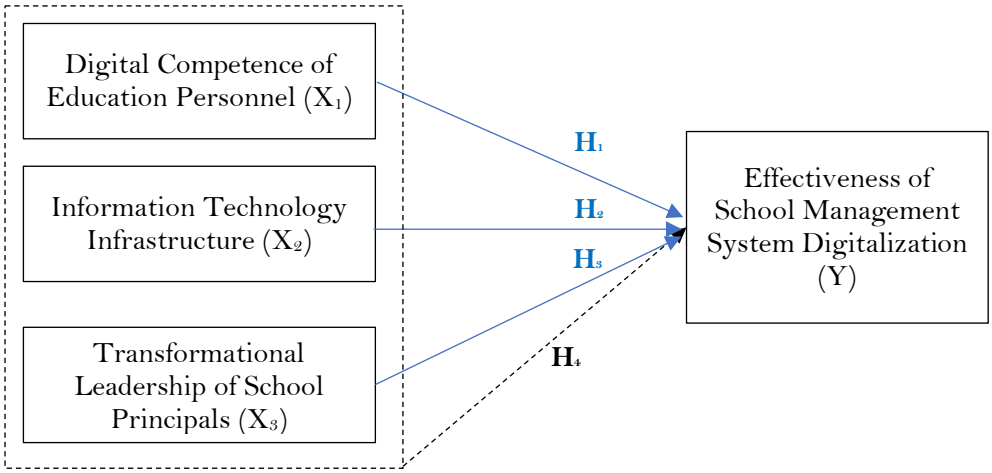


Figure 1. Research Framework

Figure 1 illustrates the relationships between three independent variables and the effectiveness of school management system digitalization. Digital competence of education personnel (X_1), information technology infrastructure (X_2), and transformational leadership of school principals (X_3) are expected to have positive, significant effects on the effectiveness of school management system digitalization (Y). Each independent variable is hypothesized to contribute individually to the dependent variable through H_1, H_2, and H_3. Furthermore, H_4 proposes that the three independent variables simultaneously have a positive and significant effect on the effectiveness of school management system digitalization in public senior high schools in Yogyakarta City.

3. Methods

This study employed a quantitative explanatory research design to examine the relationships between the digital competence of education personnel, information technology infrastructure, transformational leadership of school principals, and the

effectiveness of school management system digitalization. A quantitative design was appropriate because the study aimed to test the proposed hypotheses using numerical data and statistical analysis (Creswell & Creswell, 2018; Sekaran & Bougie, 2020). The research was conducted in all 11 public senior high schools in Yogyakarta City. The population comprised all educational personnel working in these schools, with 202 eligible personnel participating in the study. Total sampling was employed because the population was relatively limited and accessible, allowing the study to include the entire eligible population and minimize potential sampling bias.

The study examined four variables: digital competence of education personnel, information technology infrastructure, transformational leadership of school principals, and the effectiveness of school management system digitalization. Digital competence of education personnel was assessed through educational personnel's ability to use digital technologies appropriately in administrative work, including handling digital information, operating relevant applications, maintaining data security, and adapting to technological changes (Falloon, 2020). Information technology infrastructure was measured based on the availability and adequacy of technological facilities that support access, data processing, communication, and the continuous operation of digital management systems (Hu et al., 2024; Purwani et al., 2025). Transformational leadership of school principals was assessed through principals' capacity to provide direction and motivation, encourage innovative thinking, and provide individualized support during organizational change, reflecting the four dimensions proposed by Bass and Avolio. Meanwhile, the effectiveness of school management system digitalization was assessed by the extent to which digital management systems support system quality, information quality, service quality, user satisfaction, and organizational benefits, following the DeLone and McLean framework (Widyaningrum et al., 2024). All variables were measured using a five-point Likert scale.

Before the main analysis, content validity was assessed through expert judgment, while empirical validity was examined using Pearson Product-Moment correlation with 30 respondents outside the main sample. Reliability was evaluated using Cronbach's Alpha, with 0.70 as the minimum acceptable criterion. Data were analyzed using SPSS. Descriptive analysis was followed by classical assumption tests, including the Kolmogorov–Smirnov test for normality, the tolerance and Variance Inflation Factor (VIF) tests for multicollinearity, and the Glejser test for heteroscedasticity. Multiple linear regression was then applied to examine the partial effects of each independent variable and their simultaneous effect on school management system digitalization effectiveness. Statistical significance was evaluated at the 5% level.

4. Result

The study involved 202 educational personnel from 11 public senior high schools in Yogyakarta City. Data were obtained through a five-point Likert questionnaire measuring digital competence of educational personnel, information technology infrastructure, transformational leadership of school principals, and school management system digitalization effectiveness. Table 1 shows the validity and reliability test results.

Table 1. Validity and Reliability Test

Variable	Cronbach's Alpha	r-count	Decision
Digital Competence of Education Personnel	0.758	0.437–0.681	Valid & Reliable
Information Technology Infrastructure	0.766	0.452–0.704	Valid & Reliable
Transformational Leadership of School Principals	0.773	0.468–0.719	Valid & Reliable
Effectiveness of School Management System Digitalization	0.768	0.445–0.697	Valid & Reliable

The validity test showed that all questionnaire items had Pearson correlation coefficients exceeding the critical value of 0.361. Table 1 shows that the correlation coefficients ranged from 0.437 to 0.719 across the four constructs, indicating that all items met the validity criterion. Therefore, all items were retained for subsequent analysis. Reliability testing further showed Cronbach's Alpha values of 0.758 for digital competence, 0.766 for information technology infrastructure, 0.773 for transformational leadership, and 0.768 for digitalization effectiveness, confirming acceptable internal consistency.

Table 2. Normality Test

Statistics	Value
Variable	Regression Residual
Sig.	0.200
Information	Normally Distributed

Table 2 presents the normality test results for the regression residuals. The significance value was 0.200, which exceeds the 0.05 threshold commonly used to assess residual normality. This finding indicates that the residuals do not significantly deviate from a normal distribution. Therefore, the normality assumption is satisfied, suggesting the residuals are appropriately distributed for subsequent regression analysis. The results support proceeding with the regression model, as the residual distribution does not violate the normality assumption.

Table 3. Multicollinearity Test

Variable	VIF	Tolerance	Information
Digital Competence of Education Personnel	1.348	0.742	No multicollinearity
Information Technology Infrastructure	1.468	0.681	No multicollinearity
Transformational Leadership of School Principals	1.402	0.713	No multicollinearity

Table 3 reports the multicollinearity assessment for the independent variables included in the regression model. The VIF values range from 1.348 to 1.468, while the corresponding tolerance values range from 0.681 to 0.742. These results remain well within the commonly accepted thresholds, with VIF values below 5.00 and tolerance values above 0.10. Thus, digital competence of education personnel, information technology infrastructure, and transformational leadership of school principals do not exhibit problematic correlations that could distort the regression estimates. The absence of multicollinearity indicates that each predictor provides sufficiently distinct information, allowing their individual effects on the dependent variable to be estimated reliably.

Table 4. Heteroscedasticity Test

Variable	Sig.	Information
Digital Competence of Education Personnel	0.318	No heteroscedasticity
Information Technology Infrastructure	0.447	No heteroscedasticity
Transformational Leadership of School Principals	0.274	No heteroscedasticity

Table 4 presents the heteroscedasticity test results for the three independent variables. The significance values obtained for digital competence of education personnel, information technology infrastructure, and transformational leadership of school principals were 0.318, 0.447, and 0.274, respectively. All values exceed the 0.05 significance level, indicating that the absolute residuals are not significantly associated with the predictors. Accordingly, the regression model shows no evidence of heteroscedasticity. This finding suggests that residual variance remains sufficiently consistent across observations, supporting the regression model's suitability for further hypothesis testing and interpretation of relationships among the variables.

Table 5. Results of Partial Hypothesis Testing

Variable	B	Std. Error	Beta	Sig.
Constant	-1.067	–	–	–
Digital Competence of Education Personnel (X1)	0.046	0.020	0.050	0.021
Information Technology Infrastructure (X2)	1.335	0.032	0.892	<0.001
Transformational Leadership of School Principals (X3)	0.085	0.019	0.077	<0.001

According to Table 5, the regression equation is: Y = -1.067 + 0.046X1 + 1.335X2 + 0.085X3. The regression coefficient for digital competence for educational personnel (0.046) indicates that, holding the other variables constant, a one-unit increase in digital competence is associated with a 0.046-unit increase in educational personnel. Information technology infrastructure has a coefficient of 1.335, while school principals' transformational leadership has a coefficient of 0.085. All coefficients are positive, indicating that increases in the three independent variables are associated with increases in school management system digitalization effectiveness. The standardized coefficient Beta indicates the relative strength of predictors in the multiple regression model. Digital competence for educational personnel has a Beta of 0.050, information technology infrastructure has a Beta of 0.892, and transformational leadership has a Beta of 0.077. Thus, information technology infrastructure has the strongest relative effect in this model, while digital competence and transformational leadership among school principals also show positive, significant effects.

Table 5 presents the results of partial hypothesis testing examining the individual effects of the three independent variables on school management system digitalization effectiveness. Digital competence of education personnel has a positive and significant effect ($\beta = 0.050$, $p = 0.021$), supporting the first hypothesis. Information technology infrastructure has the strongest positive effect ($\beta = 0.892$, $p < 0.001$), confirming the second hypothesis. Transformational leadership of school principals also has a positive and significant effect ($\beta = 0.077$, $p < 0.001$), supporting the third hypothesis. Thus, all three hypotheses are empirically supported, indicating that each predictor contributes significantly to the effectiveness of school management system digitalization.

Table 6. Simultaneous Test (F-Test)

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	13,782.068	3	4,594.023	2,194.849	<0.001
Residual	414.432	198	2.093		
Total	14,196.500	201			

Table 6 presents the results of the simultaneous F-test, which evaluates whether digital competence of education personnel, information technology infrastructure, and transformational leadership of school principals collectively influence school management system digitalization effectiveness. The analysis yields an F-statistic of 2,194.849 with a significance level of less than 0.001. Since the significance value is below 0.05, the null hypothesis is rejected, indicating that the three independent variables jointly exert a statistically significant effect on digitalization effectiveness. Therefore, the simultaneous hypothesis is supported, confirming that digital competence, technological infrastructure, and transformational leadership collectively contribute to the effectiveness of school management system digitalization.

Table 7. Model Coefficient of Determination

Test	Value
R	0.985
R-Square	0.971
Adjusted R-Square	0.970
Std. Error of Estimate	1.447
Durbin-Watson	2.022

The model's ability to explain variation in digitalization effectiveness is indicated by the coefficient of determination. Based on Table 7, the R value of 0.985 indicates a very strong relationship between the independent variables jointly and digitalization effectiveness. The R Square value of 0.971 indicates that the research model explains 97.1% of the variation in school management system digitalization effectiveness. The remaining 2.9% is outside the research model and may be associated with other factors not analyzed in this study.

5. Discussion

Digital competence of education personnel had a positive and significant effect on school management system digitalization effectiveness, as indicated by a regression coefficient of 0.046 and a significance value of 0.021. This result indicates that higher digital competence was associated with greater digitalization effectiveness after controlling for IT infrastructure and transformational leadership. Educational personnel are not merely system users but key implementers of administrative and digital data management processes. Their ability to operate devices, manage information, use administrative applications, and adapt to digital systems supports effective school management. This finding aligns with Tømte (2024), who highlights limited digital competence among school staff as a potential barrier to educational digitalization and identifies personnel's ability to manage data, information systems, and administrative services as a key factor in the effectiveness of digital administration. Substantively, digital systems require competent users to reduce data-entry errors, speed up administrative processes, and use digital information for managerial work. Thus, competence development should emphasize practical job requirements rather than general technological skills alone.

Information technology infrastructure showed the strongest relative effect in the research model, with a regression coefficient of 1.335, a significance value of <0.001,

and the highest standardized Beta (0.892), compared with digital competence (0.050) and transformational leadership (0.077). This result indicates that infrastructure readiness was the strongest relative predictor of the effectiveness of school management system digitalization. This is because digital school management requires a stable technical foundation, including hardware, internet connectivity, applications, data storage, and technical support. When infrastructure is inadequate or disrupted, educational personnel's digital abilities cannot be fully translated into effective system performance. Thus, infrastructure serves not only as supporting facilities but also as a prerequisite for digitalization. This finding is consistent with Hu et al. (2024), who highlight hardware, software, and network limitations as barriers to educational digitalization. The findings further suggest that improving digitalization effectiveness requires sustainable infrastructure strategies, particularly stable networks, appropriate devices, system maintenance, and responsive technical support.

Transformational leadership of school principals had a positive and significant effect on school management system digitalization effectiveness, with a regression coefficient of 0.085 and a significance value of <0.001. Although its standardized Beta (0.077) was lower than that of IT infrastructure, the significant result confirms that leadership remains important in directing technology use and organizational change. Transformational leadership operates through principals' ability to establish a direction for change, motivate and support educational personnel, and foster an environment open to innovation. Digitalization involves not only adopting devices or applications but also changing work practices and administrative processes. Principals therefore play a strategic role in ensuring that digital transformation improves school governance. This finding aligns with Dema et al. (2023), who highlight transformational leadership in developing a digital vision, managing organizational change, and involving school members in digital implementation. The findings further indicate that leadership complements, rather than replaces, digital competence and IT infrastructure, and that their synergy supports effective and sustainable digitalization.

The simultaneous test showed that digital competence of education personnel, IT infrastructure, and transformational leadership of school principals jointly had a significant effect on school management system digitalization effectiveness, with an F value of 2,194.849 and significance of <0.001. The R Square value of 0.971 indicates that 97.1% of the variation in digitalization effectiveness was explained by the three predictors, while 2.9% remained outside the model. This finding supports Reis-Andersson's (2024) integrative perspective, which views educational digitalization as an organizational change process involving human resource competence, technological readiness, and leadership. Results from public senior high schools in Yogyakarta City further suggest that digitalization effectiveness is shaped by the interaction of people, technology, and organizational capacity rather than a single factor. However, the 97.1% R-squared should be interpreted as the model's explanatory capacity within the research data, not as evidence that these variables determine all digitalization outcomes. The remaining variation may reflect organizational readiness, culture, system quality, or technical support.

6. Conclusion

This study concludes that digital competence of education personnel, information technology infrastructure, and transformational leadership of school principals each have a positive and significant effect on school management system digitalization effectiveness in public senior high schools in Yogyakarta City. Among the three predictors, IT infrastructure showed the strongest relative effect ($\beta = 0.892$), followed by transformational leadership ($\beta = 0.077$) and digital competence ($\beta = 0.050$). Simultaneously, the three variables significantly affected digitalization

effectiveness ($F = 2{,}194.849$; $p < 0.001$), with an R^2 of 0.971, indicating that the model explained 97.1% of the variation in the research data. These findings show that effective school digitalization requires integrating technological readiness, human resource competence, and organizational leadership, not just technology adoption.

Schools should prioritize stable networks, appropriate devices, system maintenance, and responsive technical support while strengthening personnel's digital competence through job-relevant training and mentoring. Principals should also provide clear direction, motivation, and organizational support to ensure that digital systems are consistently integrated into administrative work. This study is limited to 202 educational personnel across 11 public senior high schools in Yogyakarta City and examines only three explanatory factors using a cross-sectional design. Future research should include broader, more diverse educational contexts and consider additional factors, such as organizational culture, system quality, organizational readiness, and technical support, using longitudinal or mixed-method approaches to provide a more comprehensive understanding of school management digitalization.

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