Artigo original

http://dx.doi.org/10.18623/rvd.v22.n2.3226

EXAMINING DIGITAL LEADERSHIP, SUPERVISION, AND LITERACY AS DETERMINANTS OF DIGITAL SERVICE QUALITY IN ELEMENTARY SCHOOLS: IMPLICATION FOR QUALITY EDUCATION IN ACHIEVING SDGS

EXAMINANDO A LIDERANÇA DIGITAL, A SUPERVISÃO E A ALFABETIZAÇÃO COMO DETERMINANTES DA QUALIDADE DO SERVIÇO DIGITAL NAS ESCOLAS DE ENSINO FUNDAMENTAL: IMPLICAÇÕES PARA A EDUCAÇÃO DE QUALIDADE NA CONSECUÇÃO DOS ODS

Article received on: 7/7/2025
Article accepted on: 9/5/2025

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The authors declare that there is no conflict of interest

Abstract
This study aims to analyze the impact of digital leadership, digital supervision, and digital literacy on the quality of digital services in primary schools in Indonesia. The research is grounded in the framework of digital transformation in education, emphasizing the roles of leadership, supervision, and literacy in enhancing digital service quality. A quantitative approach with a survey design was employed, involving 200 teachers from various regions across Indonesia selected through stratified random sampling. Data was collected via closed Likert scale questionnaire and analyzed using Structural Equation Modeling (SEM) to assess the relationship between the variables. The findings indicate that digital leadership, digital supervision, and digital literacy significantly impact the quality of digital services. Specifically, digital literacy exhibited the strongest influence, highlighting the necessity for teachers to possess robust digital competencies to support responsive and inclusive educational services. These insights can inform policymakers and educational leaders in designing strategies to enhance digital service quality in primary schools, particularly by focusing on improving educators' digital competencies. This study contributes to the understanding of how specific factors – digital leaderships, supervision, and literacy – collectively influence digital service

quality in the context of primary education, providing empirical evidence from Indonesia.

Keywords: Digitalization. Leadership. Supervision. Literacy. Service Quality. Quality Education.

Resumo
Este estudo tem como objetivo analisar o impacto da liderança digital, da supervisão digital e da alfabetização digital na qualidade dos serviços digitais em escolas de ensino fundamental na Indonésia. A pesquisa se baseia na transformação digital na educação, enfatizando os papéis da liderança, da supervisão e da alfabetização na melhoria da qualidade dos serviços digitais. Foi utilizada uma abordagem quantitativa com delineamento de pesquisa, envolvendo 200 professores de diversas regiões da Indonésia, selecionados por meio de amostragem aleatória estratificada. Os dados foram coletados por meio de questionário fechado em escala Likert e analisados por meio de Modelagem de Equações Estruturais (MEE) para avaliar a relação entre as variáveis. Os resultados indicam que a liderança digital, a supervisão digital e a alfabetização digital impactam significativamente a qualidade dos serviços digitais. Especificamente, a alfabetização digital apresentou a maior influência, destacando a necessidade de os professores possuírem competências digitais robustas para apoiar serviços educacionais responsivos e inclusivos. Esses insights podem informar formuladores de políticas e líderes educacionais na elaboração de estratégias para aprimorar a qualidade dos serviços digitais em escolas de ensino fundamental, especialmente com foco no aprimoramento das competências digitais dos educadores. Este estudo contribui para a compreensão de como fatores específicos – lideranças digitais, supervisão e alfabetização – influenciam coletivamente a qualidade dos serviços digitais no contexto do ensino fundamental, fornecendo evidências empíricas da Indonésia.

Palavras-chave: *Digitalização. Liderança. Supervisão. Alfabetização. Qualidade dos Serviços. Educação de Qualidade.*

1 INTRODUCTION

With the rapid development of technology, the quality of digital services has become a primary focus across various sectors, including education. Globally, many countries have launched digital initiatives to improve the efficiency, accessibility, and flexibility of educational services (Gasaymeh, 2018). For instance, a UNESCO report in 2021 highlighted that more than 80% of countries worldwide have implemented digital education policies to ensure more equitable and inclusive access to education (Schmitz et al., 2023). Through digital services, schools can provide access to learning materials, assignments, and assessments online, enabling students to learn anytime and anywhere. In the United States and Europe, digital services in schools have been systematically

integrated, encompassing adequate technological infrastructure, enhanced human resource capacity, and regulations supporting user safety and privacy. However, there are still global challenges in achieving optimal quality of digital services (Gürfidan & Koç, 2016; Lawrence & Tar, 2018; Reform et al., 2017). According to a study by (Christensen et al., 2018) many countries in Asia and Africa still lag in the quality of digital services in the education sector due to infrastructure and resource limitations. Moreover, research by (Fischer et al., 2020) indicates that a lack of digital literacy among educators also hinders the implementation of quality digital services, particularly in developing countries.

In Indonesia, the development of digitalization in education still faces numerous challenges, resulting in disparities in the quality of digital services in schools. Although the government has endeavored to improve technological infrastructure across various regions, the implementation of digital services in primary schools remains uneven and lacking in quality. According to a 2022 report from the Ministry of Education, Culture, Research, and Technology, only 40% of primary schools in Indonesia have adequate internet access to support digital learning activities (Prabandari et al., 2024; Purba et al., 2023). In urban areas, some schools have successfully provided good digital services; however, in rural areas, access to technology and the internet is still limited, leading to lower digital service quality. A study by (Sunarsi et al., 2020) shows that this disparity results in significant differences in learning processes, where students in urban areas have better access to digital resources compared to students in remote areas. Furthermore, according to (Desmaryani et al., 2022), the low quality of digital services in Indonesia is also due to a lack of training for teachers to effectively operate technological devices. Given this situation, there is a need to identify factors that can improve the quality of digital services, such as digital leadership, digital supervision, and teachers' digital literacy.

Although the application of digital services in schools can increase accessibility and efficiency, challenges remain in maintaining the quality of these services, especially in primary school settings. In the context of digital service quality, some commonly influential factors include digital leadership, digital supervision, and educators' digital literacy. According to (Razak et al., 2018), the quality of digital services in schools is influenced by how institutional leaders are able to direct, manage, and support digital innovation in educational environments. Additionally, research by (Yakubu & Dasuki, 2019) shows that effective supervision of technology use can optimize the utilization of digital devices and improve service quality standards. Furthermore, teachers' digital literacy is also an important factor that determines their ability to operate, utilize, and

integrate technology into the learning process ((Turgut & Aslan, 2021). Therefore, understanding these factors is a crucial first step in identifying challenges in efforts to improve the quality of digital services in primary schools.

2 THEORITICAL FRAMEWORK

Digital leadership is a strategic element in improving digital service quality, particularly as school principals play an important role in determining digital policies and strategies implemented in schools. Principals with digital leadership competencies can create a school environment that embraces technological innovation and supports comprehensive technology adoption. According to (Tanniru & Peral, 2021), strong digital leadership can foster an organizational culture oriented towards digital transformation, ultimately contributing to improved digital service quality. Additionally, effective digital leaders can provide guidance and direct support to teachers, enabling them to adapt to new digital tools and systems (ARTÜZ & BAYRAKTAR, 2021; Khemtong et al., 2024). This is evident in research by (Domeny, 2017), which found that when principals have a clear digital vision and support technology training for teachers, digital service quality improves as teachers are better prepared to use technology in teaching and learning activities.

On the other hand, research by (Acebuche, 2023) indicates that digital leadership also involves providing equitable access to technological resources across classes and school levels. Competent principals in digital leadership can address access disparities and encourage inclusive technology use. This is highly relevant in the Indonesian context, where unequal access to technology remains a challenge. (Karakose et al., 2021) found that principals with strong digital capabilities are able to bridge such limitations by designing internal policies that facilitate more equitable use of digital devices across the school environment. Based on these studies, it can be concluded that digital leadership not only determines digital service quality through infrastructure support but also through the policies, guidance, and culture created by school leaders.

H1: Digital leadership affects the digital service quality in elementary school

Digital supervision is the process by which school principals monitor the use of technology in schools to ensure it aligns with educational objectives. In this context, digital supervision not only involves monitoring hardware and software usage but also ensuring that technology is used efficiently and effectively to support learning (Prasongmanee et al., 2021). (Aldawood et al., 2019) note that consistent supervision can enhance discipline in technology use and help teachers develop stronger technical skills. Through structured supervision, school principals can ensure the quality of digital

services is maintained, as each teacher utilizes technology in ways that align with school goals (Yang & Alicia, 2022).

Yaniawati et al., 2022) found that principals who conduct regular supervision and provide feedback to teachers regarding technology use can improve educators' digital skills. This is also seen in (Kaur et al., 2015), who discovered that strong digital supervision could motivate teachers to proactively integrate technology into their teaching, creating a positive impact on digital service quality. (Vinogradova et al., 2016) argue that digital supervision involving regular evaluation helps identify challenges faced by teachers, allowing principals to provide appropriate solutions. In Indonesia, a study by (Purba et al., 2023) found that supervision involving technology-based performance assessments aids in enhancing digital service quality, as teachers are encouraged to make optimal use of technology.

H2: Digital supervision affects the digital service quality in elementary school

Teacher digital literacy plays a major role in digital service quality, as teachers with high digital literacy are generally more capable of using technology to support teaching and learning (Vermisli et al., 2022). According to (Ogundele, 2019), digital literacy includes a deep understanding of software, digital security, and effective technology use in learning. High digital literacy allows teachers to utilize various platforms and applications, enabling students to learn in more interactive and engaging ways. Teachers with high digital literacy can also mitigate technical disruptions, directly impacting the quality of digital services (Manowaluilou et al., 2024; Tuamsuk & Subramaniam, 2017).

(Janthapassa et al., 2024) emphasize the importance of digital literacy in maintaining student data security and privacy, which is a crucial aspect of digital service quality. Digitally literate teachers can implement digital security protocols, reducing risks associated with technology use. Furthermore, in Indonesia, a study by (Prabandari et al., 2024) reveals that high digital literacy among teachers enables them to efficiently access and deliver information to students, enhancing connectivity and communication effectiveness. With strong digital literacy, teachers are not only able to manage digital learning but also integrate various digital resources to support diverse learning experiences.

H3: Digital literacy affects the digital service quality in elementary school

This study aims to analyse and identify the primary factors influencing digital service quality in Indonesian primary schools. The main objective is to understand the extent to which each of these variables contributes to digital service quality enhancement, both directly and indirectly, as well as to uncover empirical evidence on the strength of the relationships between these factors and digital service quality. Understanding the role

and contributions of each of these variables is expected to provide a solid foundation for designing targeted policies and strategies to improve digital service quality in primary education.

The urgency of this research is rooted in the pressing need for more inclusive, responsive, and high-quality educational services in the fast-paced digital era. In an age of rapid technological advancement, schools as educational institutions bear the responsibility of ensuring that students have access to high-quality digital services, encompassing not only technological facilities but also responsive management and instruction that adapt to technological changes.

3 RESEARCH METHODS

This study utilizes a quantitative approach with a survey research design to measure the influence of digital leadership, digital supervision, and digital literacy on the quality of digital services in schools. Conducted in Central Java, the research focuses on teachers within the region. The research population comprises all teachers in Indonesia, while the sample consists of 200 teachers from all areas in Indonesia, selected using stratified random sampling. This sampling method enables random selection across predetermined regional strata, ensuring an accurate representation of each region.

Data collection was carried out using a closed-ended questionnaire, designed to measure all key variables. The questionnaire comprises Likert-scale questions, wherein respondents are asked to rate various statements based on their level of agreement. Upon data collection, analysis was performed using the Structural Equation Modeling (SEM) technique. SEM was selected for its ability to analyse complex relationships between independent variables, intervening variables, and dependent variables simultaneously. This method aligns with the research objectives, focusing on an in-depth understanding of how digital leadership, digital supervision, and digital literacy influence the quality of digital services. The results of the analysis are expected to provide comprehensive insights into the interaction among these variables and their implications for educational practices in the region studied.

4 RESULTS

4.1 Outer model

The outer model assesses the accuracy and reliability of the variables under study. The validity of the research is determined through two types of validity: convergent validity and discriminant validity. Reliability, on the other hand, is evaluated by examining the consistency and dependability of the indicators. Convergent validity is assessed through the Average Variance Extracted (AVE) value for each variable. A variable is considered valid if its AVE value exceeds 0.5. The AVE values obtained for each variable are as follows:

Table 1

Variable AVE Value

Variable	AVE Value	Information
Digital Leadership (X1)	0.665	Valid
Digital Supervision (X2)	0.595	Valid
Digital Literacy (X3)	0.783	Valid
Digital Service Quality (Y)	0.743	Valid

Source: processed data, 2025

As shown in the table above, all variables meet the validity criteria with AVE values exceeding 0.5. Additionally, discriminant validity is assessed by comparing the square root of the AVE values and the correlations among constructs, with discriminant validity being established when the square root of AVE values is greater than the correlations between constructs. The correlation values among variables are presented below:

Table 2

Correlations Among Latent Variables

	X1	X2	X3	Y
X1	0.816	0.346	0.702	0.714
X2	0.346	0.771	0.065	0.183
X3	0.702	0.065	0.885	0.845
Y	0.714	0.183	0.845	0.862

Source: processed data, 2025

Based on the table above, it is evident that the square root of the AVE values is greater than the correlations among constructs within the diagonal section of the variables, related to environmental knowledge, intelligence, attitudes, and behavior. This confirms that the study's variables meet the convergent and discriminant validity requirements. Additionally, reliability of the variables is assessed through composite reliability values, which should exceed 0.70. The composite reliability values for each variable are presented in the following table:

Table 3

Composite Reliability Value

Variable	Composite Reliability
Digital Leadership (X1)	0.965
Digital Supervision (X2)	0.942
Digital Literacy (X3)	0.956
Digital Service Quality (Y)	0.969

Source: processed data, 2025

According to the table above, all research variables are deemed reliable, meeting the composite reliability criterion of greater than 0.70. Next, the indicators for each variable were evaluated to identify reflective indicators. Indicators with loading factor values below 0.40 should be excluded, as they may introduce bias into the variables and hinder hypothesis testing. The following table shows the measurement of reflective indicators using loading factor values:

Table 4

Value Loading Factor

Indicators	Loading Factor	P-Value
X1.1	0.848	< 0.001
X1.2	0.797	< 0.001
X1.3	0.766	< 0.001
X1.4	0.836	< 0.001
X1.5	0.811	< 0.001
X1.6	0.815	< 0.001
X1.7	0.854	< 0.001
X1.8	0.880	< 0.001
X1.9	0.869	< 0.001
X1.10	0.832	< 0.001
X1.11	0.802	< 0.001
X1.12	0.828	< 0.001
X1.13	0.759	< 0.001
X1.14	0.704	< 0.001
X2.1	0.743	< 0.001

X2.2	0.831	< 0.001
X2.3	0.791	< 0.001
X2.4	0.772	< 0.001
X2.5	0.745	< 0.001
X2.6	0.828	< 0.001
X2.7	0.770	< 0.001
X2.8	0.723	< 0.001
X2.9	0.789	< 0.001
X2.10	0.726	< 0.001
X2.11	0.756	< 0.001
X3.1	0.868	< 0.001
X3.2	0.896	< 0.001
X3.3	0.899	< 0.001
X3.4	0.862	< 0.001
X3.5	0.895	< 0.001
X3.6	0.890	< 0.001
Y.1	0.842	< 0.001
Y.2	0.784	< 0.001
Y.3	0.811	< 0.001
Y.4	0.850	< 0.001
Y.5	0.879	< 0.001
Y.6	0.932	< 0.001
Y.7	0.848	< 0.001
Y.8	0.900	< 0.001
Y.9	0.908	< 0.001
Y.10	0.879	< 0.001
Y.11	0.839	< 0.001

Source: processed data, 2025

The loading factor values in this study exceed 0.40, indicating that no indicators need to be excluded from any variable. The indicator with the highest loading factor demonstrates its strong influence on the correlation between independent and dependent variables. With all variables meeting the outer model criteria, the research framework can proceed to analyze the inner model. In WarpPLS analysis, several fit and quality index model criteria must be satisfied, with the results shown below:

Table 5

Fit Model and Quality Index

No	Fit Model and Quality Index	Result	Note
1	APC	0.317 P < 0.001	Accepted
2	ARS	0.772 P < 0.001	Accepted
3	AARS	0.765 P < 0.001	Accepted
4	AVIF	2.054	Ideal
5	AFVIF	2.956	Ideal
6	GoF	0.733	Large
7	SPR	1.000	Ideal
8	RSCR	1.000	Ideal

9	SSR	1.000	Accepted
10	NLBCDR	0.767	Accepted

Source: processed data, 2025

The table indicates that the research model structure yields favorable results, allowing further analysis of the inner model and hypothesis testing. Therefore, both the indicator constructs and model structure are deemed satisfactory, affirming the viability of continuing with further research.

4.2 Inner model

The inner model focuses on exploring the relationships and correlations between the specified variables within the structural and conceptual framework. The figure below illustrates the correlations among the variables in this study.

Figure 1

Research Model

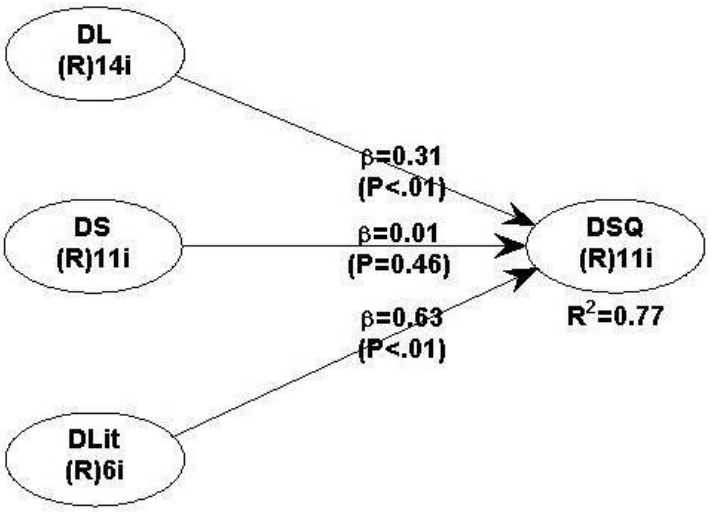

Table 6

Research Model Results

No	Line	Coefficient	Note
1	Digital leadership affects the digital service quality	< 0.001	Accepted
2	Digital supervision affects the digital service quality	0.046	Accepted

3	Digital literacy affects the digital service quality	< 0.001	Accepted

Source: processed data, 2025

5 DISCUSSION

5.1 Digital leadership to digital service quality

Based on the research findings, digital leadership has a significant influence on the quality of digital services in primary schools in Central Java, with a coefficient value of 0.31 and a p-value < 0.001. This confirms the first hypothesis, indicating that digital leadership has a strong positive impact on digital service quality. In the context of service quality theory, this finding highlights the importance of leadership as a determining factor in delivering quality services. Service quality theory emphasizes that effective leadership can enhance user satisfaction—both for staff and students—by improving access to and the quality of digital resources. Digital leadership not only encompasses a leader's technical abilities in using technology but also involves strategic skills to direct and motivate technology use across all operational aspects of the school. Through strong digital leadership, school principals can create an environment that fosters technological development, optimizes technology use, and ensures that the digital services provided by the school remain relevant and accessible to all.

This research aligns with previous studies that emphasize the importance of digital leadership in improving digital service quality in schools. A study by (Luecha et al., 2022) showed that effective digital leadership contributes significantly to increased technology use in secondary schools in the Netherlands. It found that school principals with good digital skills were able to encourage teachers and staff to engage more deeply in technology implementation. Additionally, a study (Sirisooksilp et al., 2022) in Thailand revealed that digital leadership has a direct impact on student satisfaction with digital services. Students reported higher satisfaction levels in schools where the principal focused on technology development, as they found the technology provided more relevant and responsive to their needs. Another study by (Desmaryani et al., 2022) in Indonesia reported similar findings: digital leadership was shown to improve operational efficiency and the effectiveness of technology-based learning in primary schools, demonstrating that a principal's digital skills are critical to maximizing the use of technology resources.

Moreover, the results of this study indicate that the impact of digital leadership on digital service quality is significant because principals can ensure equitable access to technological resources. Here, digital leadership entails a principal's understanding of technology's importance and efforts to provide equal access to needed technology for all staff and students. By guaranteeing equal access, principals encourage full participation from the entire school community—teachers, staff, students, and even parents—in effectively utilizing technology. This finding supports research by (Sunarsi et al., 2020), which showed that equal access to technology directly contributes to user satisfaction. A principal's commitment to providing equal access to technology demonstrates an active role in creating an inclusive and equitable learning environment. This positive impact on perceptions of digital service quality enhances both student and teacher satisfaction, as they feel supported by the principal's digital leadership.

This research also provides new insights into the role of digital leadership in primary schools, where principals not only ensure access but also consider technology use as a component in teacher performance evaluation. This policy motivates teachers to continually improve their digital skills and actively incorporate technology into their teaching practices. By integrating technology use into performance criteria, principals contribute directly to creating a school culture that supports innovation and technological adaptation. This is consistent with findings by (Lim & Teoh, 2022), which show that proactive principals who integrate technology effectively build a technology-based learning culture that, in turn, enhances teaching and learning efficiency and effectiveness. However, this study adds a new contribution by emphasizing that integrating technology into teacher performance evaluation is a key factor in encouraging teachers to actively participate in school digital programs. Through this approach, principals act not only as technology leaders but also as change agents, ensuring that the school's digital service quality continues to develop and adapt to modern advancements.

5.2 Digital supervision to digital service quality

The results indicate that digital supervision has a positive but relatively weak impact on the quality of digital services in primary schools, with a coefficient value of 0.01 and a p-value of 0.046. Although the second hypothesis is accepted, the effect observed here is relatively small. In terms of service quality theory, this result reflects

that while digital supervision is implemented by school principals, its direct impact on improving digital service quality is limited. Service quality theory emphasizes the importance of continuous interaction and evaluation of every aspect of service, including digital services. In other words, although digital supervision is an important component, this study suggests that it may require more than just supervision to substantially enhance digital service quality.

This finding can be compared with previous studies that also examined the impact of digital supervision in the educational context. A study by (Teena et al., 2024) found that digital supervision helps maintain the quality of digital learning implementation; however, its effect becomes significant only when supported by intensive technology training for teachers. This is similar to a study by (Tandi et al., 2024), which showed that digital supervision has a significant impact on digital service quality only when accompanied by a culture of technological development within the school. Their study emphasizes that supervision that is merely administrative does not yield maximum results without continuous training and guidance. Additionally, research by (Ismail, 2018) in Indonesia found that digital supervision has a small impact on digital service effectiveness in primary schools, but this effect grows when principals provide continuous guidance on technology use. This finding underscores that digital supervision must be complemented with adequate support to have a more substantial role in enhancing digital service quality. In this study, one factor that may account for the limited impact of digital supervision is that principals tend to focus only on planning online activities for classroom teaching without directly monitoring or evaluating their detailed implementation. This means that digital supervision in schools is limited to the planning stage, without intensive supervision during the implementation phase. This factor aligns with findings by (Purba et al., 2023), which show that without direct oversight of implementation, the impact of digital supervision on digital service quality diminishes. According to service quality theory, effective supervision involves not just planning but also comprehensive monitoring and evaluation of service implementation, allowing for continuous improvement.

This study also shows that principals encourage teachers to pursue higher education as a means to enhance their digital skills. Although this is intended to improve teacher competency, its short-term impact on digital service quality remains weak. This limited effect arises because developing teacher skills through further education is a time-

consuming process, making its impact on daily digital service quality less immediately evident. These findings update prior research by (Prasongmanee et al., 2021), which highlights the importance of continuous supervision and directly enhancing teachers' digital capacity through technical training. In the context of this study, encouraging teachers to pursue further education may yield positive results in the long term; however, in the short term, the effect of digital supervision on digital service quality remains weak. This new finding highlights the need for a more active approach to digital supervision, such as intensive technology training and direct monitoring, to make a stronger impact on digital service quality in primary schools.

5.3 Digital literacy to digital service quality

The research findings show that teachers' digital literacy has a very strong and significant influence on the quality of digital services in primary schools, with a coefficient value of 0.63 and a p-value < 0.001. This confirms the third hypothesis, reinforcing the view that teachers' digital literacy is a key factor in supporting digital service quality. According to service quality theory, teachers' competencies in using digital technology directly contribute to the effectiveness and efficiency of services provided to students. This theory emphasizes how quality interactions, responsive service, and user satisfaction serve as primary indicators of a quality service. With teachers possessing high digital literacy, the learning process becomes more responsive, information access is faster, and students have easier access to digitally presented materials. Therefore, teachers' digital literacy not only impacts classroom digital service quality but also enhances the overall digital learning environment in schools.

This finding is consistent with previous studies that also demonstrate the significant impact of digital literacy on service quality in the education sector. A study by (Lo et al., 2024) found that teachers with digital literacy skills are able to use various digital platforms to deliver materials, increasing student engagement and making the learning process more interactive. These findings are further supported by research by (Martínez-Serrano et al., 2023), which found that strong digital literacy allows teachers to tailor content to students' needs, utilizing interactive platforms to facilitate student access to learning materials. In Indonesia, a study by (Prabandari et al., 2024) shows that teachers' digital literacy contributes to the success of online learning, particularly in terms

of software and application usage. They found that teachers with high digital literacy can address various technical issues, enabling them to provide smoother and higher-quality educational services.

In this study, one reason for the strong influence of digital literacy on digital service quality is teachers' ability to operate a variety of hardware, software, and digital operating systems in the learning process. This capability shows that teachers not only understand basic technology but can also operate various devices that support digital learning, such as laptops, tablets, and other learning tools. Furthermore, digitally literate teachers can use different software, including classroom management applications, presentation tools, and programs for project-based learning. This is reinforced by research by (Yeşilyurt & Vezne, 2023), which found that teachers who can efficiently use a variety of digital tools provide more flexible and accessible educational services. With these capabilities, teachers can present richer and more interactive digital learning materials, which in turn enhances student satisfaction with the quality of digital services.

Another factor supporting the strong influence of digital literacy is teachers' ability to recognize and apply data privacy awareness. With high digital literacy, teachers understand the importance of protecting student data, including setting privacy protocols when using learning applications and classroom management systems. This awareness and application of data protection is a significant new finding in this study. Previous research by (Linde-Valenzuela et al., 2022) emphasized the importance of privacy awareness in online learning, but this study reinforces that such awareness improves student and parent perceptions of digital service quality. Implementing data protection shows that teachers focus not only on technology use but also on security and comfort in its application. Therefore, teachers' digital literacy, encompassing technical skills and privacy awareness, significantly enhances digital service quality in schools by creating a safe, comfortable, and trustworthy learning environment.

6 CONCLUSION

This study underscores the significant influence of digital leadership, supervision, and literacy on the quality of digital services in primary schools in Indonesia, contributing valuable insights for educational policy and practice. Digital leadership emerged as a pivotal factor, showing a strong positive impact on digital service quality by fostering an

environment conducive to technological innovation and inclusive access. The findings suggest that school leaders with robust digital competencies can create a digital culture that promotes the seamless integration of technology in teaching and learning. Additionally, digital supervision, while showing a weaker correlation to service quality, remains essential in ensuring consistent application of technology and in supporting teachers' technical skills, which contributes incrementally to the improvement of digital service delivery. These findings reinforce the notion that a structured, continuous supervision strategy enhances the reliability and accessibility of digital resources, although its immediate impact on service quality may be modest without direct interventions such as targeted training.

Digital literacy among teachers proved to have the most substantial influence on digital service quality, highlighting its critical role in effective technology use for educational service delivery. Teachers with high digital literacy can provide more engaging, secure, and accessible learning experiences by utilizing various digital platforms and resources. This aligns with global trends where digital competencies are increasingly seen as fundamental to modern educational success. Notably, the emphasis on data protection and privacy awareness within digital literacy emerged as an essential component, reflecting the growing need for security-conscious approaches in education. Thus, this study provides empirical evidence supporting the integration of digital literacy enhancement in teacher training and professional development programs. Collectively, these results inform policymakers of the essential role of digital skills across all school leadership levels and emphasize the importance of fostering an inclusive digital environment. Future research could further examine longitudinal impacts and explore additional factors that might mediate or enhance these relationships in the digital educational landscape.

REFERENCES

Acebuche, A. C. (2023). Digital Leadership Towards Effective School Management: A Systematic Review. *Psychology and Education: A Multidisciplinary Journal*, *16*(2), 174–191. https://doi.org/10.5281/zenodo.10451815

Aldawood, H., Alhejaili, A., Alabadi, M., Alharbi, O., & Skinner, G. (2019). Integrating Digital Leadership in an Educational Supervision Context: A Critical Appraisal. *2019 International Conference on Engineering Applications, ICEA 2019 - Proceedings*, 1–7. https://doi.org/10.1109/CEAP.2019.8883484

ARTÜZ, S. D., & BAYRAKTAR, O. (2021). the Effect of Relation Between Digital Leadership Practice and Learning Organization on the Perception of Individual Performance. *İstanbul Ticaret Üniversitesi Sosyal Bilimler Dergisi*, *20*(40), 97–120. https://doi.org/10.46928/iticusbe.761479

Christensen, R., Eichhorn, K., Prestridge, S., Petko, D., Sligte, H., Baker, R., Alayyar, G., & Knezek, G. (2018). Supporting Learning Leaders for the Effective Integration of Technology into Schools. *Technology, Knowledge and Learning*, *23*(3), 457–472. https://doi.org/10.1007/s10758-018-9385-9

Desmaryani, S., Kusrini, N., Lestari, W., Septiyarini, D., Harkeni, A., Burhansyah, R., Kilmanun, J. C., Dewi, D. O., Syafutra, M. R., David, J., Darmawan, & An-Driany, E. (2022). The role of digital leadership, system of information, and service quality on e-learning satisfaction. *International Journal of Data and Network Science*, *6*(4), 1215–1222. https://doi.org/10.5267/j.ijdns.2022.6.012

Domeny, J. (2017). *The Relationship between Digital Leadership and Digital Implementation in Elementary Schools*. 132.

Fischer, G., Lundin, J., & Lindberg, J. O. (2020). Rethinking and reinventing learning, education and collaboration in the digital age—from creating technologies to transforming cultures. *International Journal of Information and Learning Technology*, *37*(5), 241–252. https://doi.org/10.1108/IJILT-04-2020-0051

Gasaymeh, A. M. (2018). A study of undergraduate students' use of Information and Communication Technology (ICT) and the factors affecting their use: A developing country perspective. *Eurasia Journal of Mathematics, Science and Technology Education*, *14*(5), 1731–1746. https://doi.org/10.29333/EJMSTE/85118

Gürfidan, H., & Koç, M. (2016). The impact of school culture, technology leadership, and support services on teachers' technology integration: A structural equation modeling. *Egitim ve Bilim*, *41*(188), 99–116. https://doi.org/10.15390/EB.2016.6722

Ismail, I. binti. (2018). An Important Role of Educational Supervision in the Digital Age. In *COUNS-EDU: The International Journal of Counseling and Education* (Vol. 3, Issue 4). https://doi.org/10.23916/0020180314230

Janthapassa, S., Chanthapassa, N., & Kenaphoom, S. (2024). The Role of Digital Literacy in Shaping Education in the Next-Normal. *Asian Education and Learning Review*, *2*(1), 2985–2862.

Karakose, T., Polat, H., & Papadakis, S. (2021). Examining teachers' perspectives on school principals' digital leadership roles and technology capabilities during the covid-19 pandemic. *Sustainability (Switzerland)*, *13*(23). https://doi.org/10.3390/su132313448

Kaur, S., Sidhu, G. K., Fong, L. L., & Jamian, L. S. (2015). Supervisory and digital literacy practices in postgraduate supervision: A case study. *Proceedings of the 12th International Conference on Cognition and Exploratory Learning in the Digital Age, CELDA 2015*, *Celda 2015*, 35–42.

Khemtong, N., Promchom, K., Thumsen, P., & Wechayalak, N. (2024). Digital Leadership Relationships Among School Administrators with the Effectiveness of Academic Work in the New Normal Era. *Higher Education Studies*, *14*(3), 38. https://doi.org/10.5539/hes.v14n3p38

Lawrence, J. E., & Tar, U. A. (2018). Factors that influence teachers' adoption and integration of ICT in teaching/learning process. *Educational Media International*, *55*(1), 79–105. https://doi.org/10.1080/09523987.2018.1439712

Lim, C. H., & Teoh, A. P. (2022). Predicting the Influence of Digital Leadership on Performance of Private Higher Education Institutions: Evidence from Malaysia. *Journal of Entrepreneurship,Business and Economics*, *10*(1), 1–38.

Linde-Valenzuela, T., Guillen-Gamez, F. D., & Devitt, A. (2022). Digital Literacy of Teachers, Families, and Students for Virtual Participation in School: A Multiple Comparison Analysis. *Revista Iberoamericana de Tecnologias Del Aprendizaje*, *17*(1), 1–8. https://doi.org/10.1109/RITA.2022.3149800

Lo, H. C., Wang, T. H., & Chen, R. S. (2024). Enhancing Critical Digital Literacy of Preservice Preschool Teachers through Service Learning: The Moderator of Online Social Capital. *Sustainability (Switzerland)* , *16*(6). https://doi.org/10.3390/su16062253

Luecha, C., Chantarasombat, C., & Sirisuthi, C. (2022). Program Development of Digital Leadership for School Administrators Under the office of Primary Educational Service Area. *World Journal of Education*, *12*(2), 15. https://doi.org/10.5430/wje.v12n2p15

Manowaluilou, N., Thanarachataphoom, T., Pimthong, P., Ugsornkid, S., & Ketkosan, N. (2024). Digital literacy and fluency in education: Enhancing teacher education preparedness policy. *Journal of Infrastructure, Policy and Development*, *8*(8), 1–25. https://doi.org/10.24294/jipd.v8i8.4415

Martínez-Serrano, M. del C., Romero-García, M. A., García-Martínez, I., & Gavín-Chocano, Ó. (2023). Inspection Digital Literacy for School Improvement. *European Journal of Investigation in Health, Psychology and Education*, *13*(4), 701–714. https://doi.org/10.3390/ejihpe13040053

Ogundele, M. O. (2019). Managing Digital Literacy for Quality Assurance of Federal Universities in North Central Nigeria. *Proceedings on Engineering Sciences*, *1*(2), 645–654. https://doi.org/10.24874/PES01.02.065

Prabandari, R. C. S. W., Fitria, H., & Effendi, D. (2024). The Effect of Digital Literacy and Character Education on Increasing the Quality of Learning. *Journal of Social Work and Science Education*, *5*(2), 612–623. https://doi.org/10.52690/jswse.v5i2.798

Prasongmanee, C., Wannapiroon, P., & Nilsook, P. (2021). Synthesis of Digital Supervisor Competency. *Proceedings - 2021 Research, Invention, and Innovation Congress: Innovation Electricals and Electronics, RI2C 2021*, 161–166. https://doi.org/10.1109/RI2C51727.2021.9559792

Purba, S., Hasan, A., Panjaitan, K., & Maruli, B. (2023). Digital Supervision and Team Work of Science Education at Vocational School. *Jurnal Penelitian Pendidikan IPA*, *9*(SpecialIssue), 533–538. https://doi.org/10.29303/jppipa.v9ispecialissue.6404

Razak, N. A., Jalil, H. A., Krauss, S. E., & Ahmad, N. A. (2018). Successful implementation of information and communication technology integration in Malaysian public schools: An activity systems analysis approach. *Studies in*

Educational Evaluation, *58*(June 2017), 17–29. https://doi.org/10.1016/j.stueduc.2018.05.003

Reform, C., Design, I., Presi-, V., & Educa-, S. (2017). Theorizing Teaching and Learning in Asia and Europe. In *Theorizing Teaching and Learning in Asia and Europe*. https://doi.org/10.4324/9781315751900

Schmitz, M. L., Antonietti, C., Consoli, T., Cattaneo, A., Gonon, P., & Petko, D. (2023). Transformational leadership for technology integration in schools: Empowering teachers to use technology in a more demanding way. *Computers and Education*, *204*(March), 104880. https://doi.org/10.1016/j.compedu.2023.104880

Sirisooksilp, S., Kampang, K., & Ariratana, W. (2022). *The Effect of Digital Leadership on School Administrators Towards Primary School Effectiveness : A Structural Equation Modeling*. *20*(16), 3769–3777. https://doi.org/10.48047/NQ.2022.20.16.NQ880381

Sunarsi, D., Rohaeni, N., Wulansari, R., Andriani, J., Muslimat, A., Rialmi, Z., Kustini, E., Kristianti, L. S., Rostikawati, D., Effendy, A. A., Purwanto, A., & Fahlevi, M. (2020). Effect of e-leadership style, organizational commitment and service quality towards indonesian school performance. *Systematic Reviews in Pharmacy*, *11*(10), 472–481. https://doi.org/10.31838/srp.2020.10.71

Tandi, A., Allo, Y. T., & Tolla, Y. (2024). Implementation Of The Supervision System, Components Of The Supervision System And The Function Of The Supervision System For Digital-Based Supervision In The North Toraja Regency Inspectorate. *Journal Research of Social Science, Economics, and Management*, *3*(6), 1385–1408. https://doi.org/10.59141/jrssem.v3i6.610

Tanniru, M., & Peral, J. (2021). Digital Leadership in Education. *Effective Leadership for Overcoming ICT Challenges in Higher Education: What Faculty, Staff and Administrators Can Do to Thrive Amidst the Chaos*, 73–91. https://doi.org/10.1108/978-1-83982-306-020211008

Teena, W., Nuntee, S., & Inyai, C. (2024). A Model for Supervision Management to Improve the Education by Using the Area as Base in Digital Era under Primary Educational Service Area in the Northeastern Region. *International Education Studies*, *17*(2), 80. https://doi.org/10.5539/ies.v17n2p80

Tuamsuk, K., & Subramaniam, M. (2017). The current state and influential factors in the development of digital literacy in Thailand's higher education. *Information and Learning Science*, *118*(5–6), 235–251. https://doi.org/10.1108/ILS-11-2016-0076

Turgut, Y. E., & Aslan, A. (2021). Factors affecting ICT integration in TURKISH education: a systematic review. *Education and Information Technologies*, *26*(4), 4069–4092. https://doi.org/10.1007/s10639-021-10441-2

Vermisli, S., Cevik, E., & Cevik, C. (2022). The Effect of Perceived Stress and Digital Literacy on Student Satisfaction with Distance Education. *Revista Da Escola de Enfermagem*, *56*, 1–8. https://doi.org/10.1590/1980-220X-REEUSP-2021-0488EN

Vinogradova, M. V., Kulyamin, O. S., Larionova, A. A., Maloletko, A. N., & Kaurova, O. V. (2016). Digital technology in the field of educational services. *International Review of Management and Marketing*, *6*(2), 281–287.

Yakubu, M. N., & Dasuki, S. I. (2019). Factors affecting the adoption of e-learning technologies among higher education students in Nigeria: A structural equation modelling approach. *Information Development*, *35*(3), 492–502. https://doi.org/10.1177/0266666918765907

Yang, L., & Alicia, F. M. (2022). teachers ´ perception of digital competencies in the Chinese region of Anhui. *Education and Information Technologies*, 12469–12494.

Yaniawati, P., Maat, S. M., Supianti, I. I., & Fisher, D. (2022). European Journal of Educational Research. *European Journal of Educational Research*, *11*(1), 69–81.

Yeşilyurt, E., & Vezne, R. (2023). Digital literacy, technological literacy, and internet literacy as predictors of attitude toward applying computer-supported education. *Education and Information Technologies*, *28*(8), 9885–9911. https://doi.org/10.1007/s10639-022-11311-1

Authors' Contribution

Both authors contributed equally to the development of this article.

Data availability

All datasets relevant to this study's findings are fully available within the article.

How to cite this article (APA):

Kardoyo, K., & Pitaloka, L. K. (2025). EXAMINING DIGITAL LEADERSHIP, SUPERVISION, AND LITERACY AS DETERMINANTS OF DIGITAL SERVICE QUALITY IN ELEMENTARY SCHOOLS: IMPLICATION FOR QUALITY EDUCATION IN ACHIEVING SDGS. *Veredas Do Direito*, *22*(2), e3226. https://doi.org/10.18623/rvd.v22.n2.3226