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Effectiveness of Elementary School Management through Digital Literacy, Infrastructure Readiness, Hybrid-Based Organizational Culture (Integration of Artificial Intelligence and Data-Driven Decision Making): An Empirical Study

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Abstract

This paper explored the effectiveness of elementary school management based on a hybrid model that means fusing data driven decision making with artificial intelligence in government elementary schools in the Gorontalo Regency of Indonesia. The study utilized a quantitative explanatory research design to explore the impact of digital literacy, infrastructure preparedness, and organization culture on the effectiveness of school management. The sample size consisted of principals, teachers, and administrative personnel and 205 respondents were chosen by proportional stratified random sampling. A Likert scale questionnaire was used to gather data and Structural Equation Modeling with Partial Least Squares was used to analyze the data. The results found that digital literacy, infrastructure preparedness, and organizational culture had a positive impact on management effectiveness. The strongest predictor was found to be digital literacy and then organizational culture and infrastructure readiness became the predictors. These three predictors had a high explanatory power, and the value of R square was 0.714, which showed that three predictors explained 71.4 percent of the variance in the effectiveness of management in schools. These findings imply that effective deployment of hybrid data based and AI supported school management does not merely require the presence of technology but also the ability of school actors to comprehend data, cooperate and maintain adaptable organizational behavior. This research concludes that the promotion of effective and context sensitive digital transformation in the management of elementary schools must be made priorities by enhancing digital literacy and cultivating a positive organizational culture.

Introduction

The development of digital technology has revolutionized various aspects of life, including the primary education system. Globally, educational transformation now focuses not only on learning methods but also on the management aspects of educational institutions. The concept of data-driven decision-making (DDDM) and the integration of artificial intelligence (AI) into school managerial decision-making have begun to gain prominence in modern education policy studies. This concept emphasizes that data-driven decisions and the support of intelligent systems can improve the efficiency, transparency, and responsiveness of education management to operational and academic challenges (Reigeluth & Karnopp, 2013; Chen et al., 2021; Gonugunta & Leo, 2024; Gurram et al., 2025; Munagandla et al., 2024; Gurram et al., 2025).

Elementary schools, as the most basic level of education, face unique challenges in implementing digital-based management (Khofi & Santoso, 2024; Gurram et al., 2025). As

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entities operating within socio-cultural complexities and with limited resources, elementary schools in non-metropolitan areas face significant gaps in digital management transformation. In Indonesia, particularly in Gorontalo Regency, this is a pressing concern. According to data from the Gorontalo Regency Central Statistics Agency (2020), there are 298 elementary schools (public and private), with an enrollment of over 38,500 students. The overall teacher-student ratio is 1:19, which generally meets national standards, but its distribution remains uneven across sub-districts (BPS Gorontalo, 2020; Abduh et al., 2026).

In terms of institutional quality, elementary school accreditation data shows that approximately 23.04% of public elementary schools have achieved A accreditation, while 41.18% have B accreditation, and a small proportion remain in category C or unaccredited (daftarsekolah.net, 2025). This illustrates relative readiness to accept technology-based management model interventions, but has not yet reached the optimal phase. Furthermore, access to information technology remains a challenge that has not been fully addressed. According to national data from the Ministry of Education, Culture, Research, and Technology, only approximately 54% of elementary schools outside Java have adequate internet access to support digital-based learning and management (Kemendikbud, 2022).

Although national programs such as the Computer-Based National Assessment (ANBK) have been implemented comprehensively in Gorontalo Regency, this technology implementation focuses more on learning evaluation, rather than management. There are few systemic interventions that integrate DDDM and AI concepts into comprehensive elementary school managerial decision-making.

This research gap arises from the lack of conceptual and practical models that integrate DDDM and AI in the context of community-based elementary school management and address regional needs. Principals' digital literacy, ICT infrastructure, and school organizational culture are key variables that have not been thoroughly explored as determinants of successful digital school management transformation (Timotheou et al., 2023; Mhlungu et al., 2019).

Therefore, this study aims to develop and test a hybrid model of DDDM and AI-based school management in elementary schools in Gorontalo Regency. This model is expected to address local challenges such as low adoption of digital management systems, limited human resources skilled in data analytics, and an unprepared organizational culture for adopting intelligent systems.

Therefore, the results of this study are expected to contribute to the development of digitalization-based educational management theory, improve managerial practices in elementary schools in the region, and provide data-driven and contextual policy input addressing the needs of digital transformation in Indonesian elementary education.

This research generally aims to develop and test a hybrid school management model based on data-driven decision making (DDDM) and artificial intelligence (AI) in the context of elementary schools in Gorontalo Regency. The specific objectives of this research are as follows: 1) Design a hybrid management model based on DDDM and AI that is relevant, adaptive, and aligned with the needs and capacities of elementary schools in Gorontalo Regency, both in terms of institutions, human resources, and digital infrastructure; 2) Test the effectiveness of this hybrid model in improving the quality and efficiency of managerial decision-making in elementary schools, particularly in the areas of planning, monitoring, and evaluation based on accurate and real-time data.; 3) Identify and analyze the role of digital literacy, infrastructure readiness, and school organizational culture as mediating or moderating variables influencing the successful implementation of a technology-based hybrid management

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model; 4) Evaluate the level of acceptance and readiness of school principals and educators in adopting a managerial approach based on smart technology and information systems, taking into account the dimensions of perceived usefulness and perceived ease of use based on the Technology Acceptance Model; 5) Provide strategic recommendations to education policymakers at the regional and national levels regarding the development of effective, locally context-based, and sustainable digitalization-based elementary education management.

Based on the background, objectives, and urgency of transforming elementary education management to adapt to technological developments, the research problem addressed in this study is:

> *"How can we design and test a hybrid model of school management based on data-driven decision-making and artificial intelligence that is effective, adaptive, and contextual for implementation in elementary schools in Gorontalo Regency?"*

This question is broken down into several operational problem formulations as follows:

What are the characteristics of the current elementary school management system in Gorontalo Regency regarding the use of data and technology in decision-making?

How can a hybrid model design that combines a data-driven decision-making approach and the use of artificial intelligence be adapted to the local context of elementary schools in Gorontalo Regency?

How significant is the impact of implementing a hybrid school management model on the effectiveness of decision-making and the operational efficiency of elementary education institutions?

What are the roles of digital literacy, infrastructure readiness, and organizational culture as mediating or moderating variables in the success of the model implementation?

What are the perceptions of school principals and teachers regarding the ease and benefits of using data- and AI-based managerial technology based on the Technology Acceptance Model framework?

Theoretical Review

Open System Theory

Open Systems Theory was introduced by Katz and Kahn (1978) as an approach that explains that organizations are systems that constantly interact with the external environment. Schools, as educational institutions, cannot stand alone; they depend on inputs from the environment, such as policies, human resources, technology, and community support. Within this framework, educational organizations are dynamic continuously adapting to social, economic, and technological changes to remain relevant (Kovalenko et al., 2021; Aithal & Maiya, 2023; Akimov et al., 2023). Open systems enable schools to modify their management structures and strategies to maintain balance (homeostasis) with their environment.

In the context of educational management in Gorontalo Regency, this theory emphasizes that digital transformation is driven not only by internal factors such as the competence of school principals, but also by external pressures in the form of national policies, technological developments, and public expectations for transparency in school performance. Therefore, adopting the hybrid DDDM–AI model represents an organizational adaptation to changes in the digital education ecosystem. Schools that operate as open systems are better able to utilize data, information, and technology from their environment to optimize managerial performance (Sunarjo et al., 2024; Adeleke et al., 2024).

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Katz and Kahn also emphasize the importance of feedback loops in open systems. In DDDM–AI-based school management, feedback is derived from data analysis of student performance, teacher effectiveness, and administrative efficiency. This mechanism allows schools to make corrections and policy adjustments based on empirical evidence. Thus, open systems theory serves as the epistemological foundation for data-driven management, as both are oriented toward a continuous cycle of adaptation between input, process, and output.

From a theoretical perspective, the application of open systems theory in digital education emphasizes that schools must be able to transform into learning organizations that not only collect data but also process it into institutional knowledge. This information processing process is at the heart of the application of data-driven decision making (DDDM) and the integration of artificial intelligence (AI) as a modern decision support system (Katz & Kahn, 1978; Mamun, 2025; Rahman, 2024; Alenezi, 2023; Zhao et al., 2023).

Data-Driven Decision Making (DDDM) Theory

Data-Driven Decision Making (DDDM) theory was developed from an evidence-based management approach, emphasizing that organizational policies and decisions should be based on data analysis, not intuition alone. In the educational context, DDDM serves as a rational mechanism for interpreting student learning outcomes, attendance, teacher performance, and school financial data. This allows principals to identify problems, set priorities, and make concrete, evidence-based decisions (Marsh et al., 2006; DeMatthews & Wang, 2023; Williams et al., 2021).

In its implementation, DDDM requires a data culture an organizational culture that values accurate information and openness to analytical results. According to Wayman and Stringfield (2006), the successful implementation of DDDM depends on three main pillars: the availability of quality data, user competence in data analysis, and policy support from the education system. In elementary schools in Gorontalo, these pillars still face challenges such as low data literacy and a lack of ICT infrastructure to support informed decision-making (Hamdanah, 2025; Widiastuti, 2025).

Furthermore, DDDM theory is oriented towards a process cycle that includes data collection, interpretation, action planning, and evaluation of results. In this research, DDDM serves as the operational basis for developing a hybrid management model based on data and artificial intelligence. When applied systematically, DDDM can improve administrative efficiency, accelerate policy feedback, and strengthen school public accountability (AlShammari & AlAjmi, 2025).

Conceptually, DDDM supports the principle of open systems by making information the lifeblood of an organization. The integration of DDDM and AI creates a decision-making model that is not only descriptive but also predictive and prescriptive. Schools no longer simply react to data but can anticipate future trends such as declining student performance or the need for new teachers (Marsh et al., 2006; Berry, 2011).

The Concept of Artificial Intelligence (AI) in Educational Management

The concept of Artificial Intelligence (AI) in education evolved from the idea that technology can expand human capacity for thinking, analyzing, and making decisions. In the context of educational management, AI serves not as a replacement for humans, but as a decision support system that helps principals and teachers analyze data patterns to design more effective policies (Holmes et al., 2019; Dai et al., 2025; Okokoyo et al., 2024; Shwedeh, 2024). AI works through three main approaches: machine learning, natural language processing, and predictive analytics.

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The integration of AI into school management enables the analysis of big data, including academic performance, attendance, and budget allocation (Koukaras et al., 2025; Esomonu, 2025). AI technology can detect anomalies or patterns that are invisible manually, such as declining student learning outcomes in certain areas. Thus, AI becomes a strategic instrument in an early warning system in education, supporting evidence-based policy. This is particularly relevant in Gorontalo Regency, which still faces the challenge of limited human resources in data analysis.

AI is also driving the emergence of a new paradigm called AI-augmented management, where intelligent systems provide policy recommendations that can be empirically tested by principals. In this context, humans remain the primary decision-makers, while AI serves as an analytical partner. This approach aligns with the hybrid model developed in this study, where AI serves as a predictive component, while DDDM forms the foundation for evidence-based analysis.

Theoretically, the application of AI strengthens the principles of efficiency, adaptability, and innovation in school management. AI helps create a continuous organizational learning cycle through the utilization of real-time data. The integration of AI and DDDM with an open systems approach transforms schools into organizations capable of collective thinking through automated analytics support (Chen et al., 2021; Qudrat-Ullah, 2024; Evenstein Sigalov et al., 2025).

Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM) theory was developed by Davis (1989) to explain how users accept and use new technologies. TAM asserts that two key constructs Perceived Usefulness (PU) and Perceived Ease of Use (PEOU) determine an individual's intention to adopt technology. In the context of AI-based educational management, these perceived usefulness and ease of use are key to determining the success of digital system implementation.

In this study, TAM was used to explain the extent to which school principals and teachers in Gorontalo were willing to adopt a DDDM–AI-based management system. Principals who understood the benefits of technology in decision-making demonstrated a higher level of acceptance. However, if the technology was perceived as complicated or irrelevant, adoption rates would be low. Therefore, digital literacy served as a predictor for both constructs.

Furthermore, TAM can be expanded into an Extended TAM that includes external factors such as organizational support, school culture, and digital training. In the context of this study, organizational culture and infrastructure readiness were variables that mediated the relationship between user perceptions and the effectiveness of technology implementation. Thus, TAM not only explains individual behavior but also illustrates organizational dynamics related to technological innovation.

The application of TAM in education emphasizes the importance of building trust and ownership of new technologies. In Gorontalo, the success of the hybrid DDDM–AI model depended heavily on the collective perception of the technology's benefits in improving work efficiency and transparency in school management (Davis, 1989).

Organizational Culture Theory

The organizational culture theory developed by Schein (2010) states that culture is a system of values, beliefs, and norms that shape the behavior of organizational members. Organizational culture determines how members respond to change, innovate, and collaborate to achieve

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collective goals. In education, an inclusive and adaptive organizational culture is crucial for effectively integrating digital technology.

In the context of elementary schools in Gorontalo, an organizational culture rooted in local values such as Huyula (mutual cooperation) and Pohutu (social empathy) provides a strong foundation for building digital collaboration. These values can strengthen shared commitment to technology adoption, as they emphasize collective responsibility and solidarity among school members. When local cultural values are integrated into modern management systems, the digital transformation process becomes more contextualized and socially acceptable.

Furthermore, organizational culture theory asserts that the success of technological innovation depends on the extent to which new values can be internalized without erasing the organization's old identity. In this case, digital transformation does not mean eliminating tradition, but rather expanding the space for collaboration and innovation through technological support. This approach is known as cultural adaptive transformation.

Thus, organizational culture in this study acts as a mediating variable linking technological readiness and digital literacy with school management effectiveness. Schools with an open and supportive culture toward innovation tend to be more successful in implementing a DDDM–AI-based hybrid management model (Schein, 2010; Barile et al., 2026).

Methods

This study used a quantitative approach with explanatory research methods. It aimed to examine the causal relationship between digital literacy, infrastructure readiness, organizational culture, and the effectiveness of elementary school management based on a hybrid data-driven decision-making (DDDM) and artificial intelligence (AI) model in Gorontalo Regency. The quantitative approach was chosen because it oriented toward objective measurement and hypothesis testing, with generalizable results (Creswell & Creswell, 2018). The study was conducted in Gorontalo Regency, Gorontalo Province, encompassing six main sub-districts: Limboto, Telaga, Bongomeme, Tibawa, Batudaa, and Tolangohula. This location was chosen because it represents the conditions of elementary education in non-metropolitan areas adapting to digital transformation.

The study population included all principals and teachers of public elementary schools in the region, totaling 298 schools with a total of approximately 420 target respondents.

The sampling technique used was proportional stratified random sampling, based on school accreditation status and the availability of ICT infrastructure.

The Slovin formula is used to determine the sample size:

$$n = \frac{N}{1 + N\,(e)^2}$$

Description:

n = number of samples required

N = population size

E = error tolerance, usually 0.05 (5%) or 0.10 (10%)

The population (N) is 420 respondents (primary school principals and teachers in Gorontalo Regency), and the error tolerance (e) is set at 0.05 (5%), so the calculation is:

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$$n = \frac{420}{1 + 420\ (0{,}05)^2}$$

$$n = \frac{420}{1 + 420\ (0{,}0025)}$$

$$n = \frac{420}{1 + 1{,}05}$$

$$n = \frac{420}{2{,}05}$$

$$n = 204{,}88$$

From these results, the number of samples taken was rounded up to 205 respondents. To be representative of all groups in the population, the Proportional Stratified Random Sampling technique was used, as illustrated in Table 3.1.

Table 1. Sample Distribution Based on Position Proportion

Stratum	Population	Proportion (%)	Sample Size
School Principals	126	30%	61
Classroom Teachers	210	50%	102
Administrative Staff	84	20%	42
Total	**420**	**100%**	**205**

Reasons for choosing the Slovin Formula: 1) it is suitable for use when the population is clearly known and the population heterogeneity is relatively high; 2) it avoids bias in estimating sample size; 3) it is easy to apply to educational research that uses survey methods (Creswell, 2018)

The variables and operational definitions are depicted in Table 3.2 below.

Table 2. Research Variables

Variable	Operational Definition	Main Indicators
Digital Literacy (X1)	The level of teachers' and principals' ability to use information technology for planning and decision-making	Technical competence, digital ethics, online collaboration
Infrastructure Readiness (X2)	Availability of technological facilities and infrastructure in schools	Internet access, hardware, administrative systems
Organizational Culture (X3)	Values, norms, and attitudes in adopting digital innovation within schools	Adaptability, collaboration, learning orientation
Elementary School Management Effectiveness	The level of success of management in data-based planning, implementation, and evaluation	Decision efficiency, policy accuracy, academic performance

Research Instruments

The primary research instrument was a Likert-scale questionnaire (1–5) consisting of 35 statement items. Content validity was examined through expert judgment involving three experts in educational management and educational technology. Reliability testing was conducted using Cronbach's Alpha, with a threshold of $\alpha \geq 0.70$ indicating acceptable reliability (Hair et al., 2019).

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Data Analysis Techniques

Data analysis was carried out in two stages. First, descriptive analysis was employed to describe respondent characteristics and the overall condition of the research variables. Second, inferential analysis was conducted using Structural Equation Modeling with Partial Least Squares (SEM-PLS) through the SmartPLS software. This model was used to analyze latent variable relationships and to test the proposed structural hypotheses.

Model Assumption Tests

Several model evaluation tests were conducted, including:

Convergent Validity Test: Average Variance Extracted (AVE) > 0.50

Composite Reliability Test: Composite Reliability (CR) > 0.70

Multicollinearity Test: Variance Inflation Factor (VIF) < 5

Goodness of Fit (GoF), calculated using the following formula:

GoF=(AVE×R2)GoF = \sqrt{(AVE \times R^2)}GoF=(AVE×R2)

as proposed by Tenenhaus et al. (2005).

Research Hypotheses

H1: Digital literacy has a positive effect on elementary school management effectiveness.

H2: Infrastructure readiness has a positive effect on elementary school management effectiveness.

H3: Organizational culture has a positive effect on elementary school management effectiveness.

H4: Digital literacy, infrastructure readiness, and organizational culture simultaneously have a positive effect on elementary school management effectiveness based on the hybrid DDDMAI model.

If you want, I can tighten the language to match Q1 journal standards, or align it precisely with SEM-PLS reporting conventions (e.g., Hair et al., 2021).

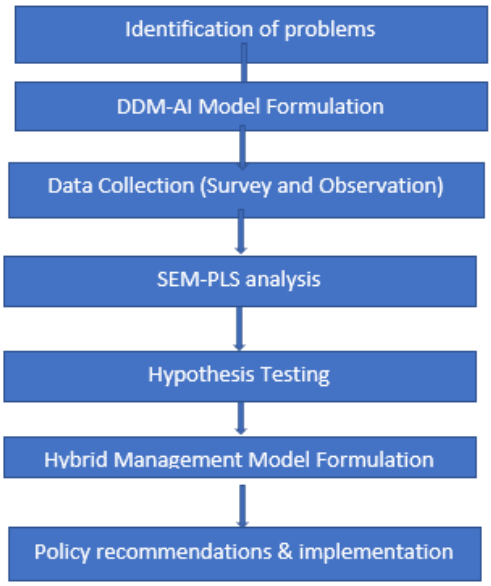

Figure 1. Research Flow

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Results and Discussion

The Results section demonstrates commendable organization, particularly in its presentation of descriptive statistics which clearly outline mean values and standard deviations across the core variables. The structure of SEM-PLS assessment is technically appropriate and aligns with standard analytical procedures. Furthermore, the reporting of hypothesis outcomes is well executed, offering beta coefficients, significance levels, t-statistics, and p-values that provide clear evidence of the relationships tested. While this quantitative presentation is strong, the interpretation remains primarily descriptive rather than analytical. The manuscript notes, for instance, that digital literacy has the strongest effect on management effectiveness ($\beta = 0.413$), yet it does not explore what this magnitude implies relative to the influence of organizational culture and infrastructure readiness. This is a missed opportunity to provide richer insight into the role of digital capability in shaping managerial performance within elementary schools.

In addition, the Results section could benefit from visual representation such as structural model diagrams or path coefficient charts. These would not only enhance readability but also allow readers to quickly interpret variable interactions and effect sizes. The justification for considering $R^2 = 0.714$ as a strong explanatory power should be grounded in recognized literature benchmarks, such as Hair et al. (2019), which categorize values above 0.67 as substantial. Incorporating this reference would strengthen methodological justification. Likewise, the Goodness of Fit (GoF) index, while reported as high, requires more nuanced handling. Recent SEM-PLS methodological discussions argue that GoF is no longer widely recommended as a primary fit index, and many contemporary studies prefer alternative indicators such as SRMR, NFI, or exact model fit statistics. The manuscript should therefore either provide a rationale for retaining GoF or complement it with additional recommended indices to align the analysis with current methodological expectations.

General Description of Respondents

Respondent Profile

This study involved 205 respondents, consisting of 61 school principals (30%), 102 classroom teachers (50%), and 42 administrative staff members (20%) from 43 public elementary schools in Gorontalo Regency. In terms of gender distribution, 62% of respondents were female and 38% were male. The majority of respondents were aged 31–45 years (57%), and 48% had more than 10 years of work experience.

From a digital literacy perspective, approximately 71% of respondents reported being able to use online-based administrative applications, while only 43% were accustomed to conducting data analysis using Excel, SPSS, or basic AI-supported platforms. This condition highlights the urgent need to strengthen digital capacity among educators in non-metropolitan regions.

Descriptive analysis was conducted on four main variables: Digital Literacy (X_1), Infrastructure Readiness (X_2), Organizational Culture (X_3), and School Management Effectiveness (Y).

Table 3. Descriptive Statistics of Research Variables

Variable	Mean (M)	Standard Deviation (SD)	Category
Digital Literacy (X_1)	3.94	0.61	High
Infrastructure Readiness (X_2)	3.68	0.74	Moderately High
Organizational Culture (X_3)	4.02	0.57	High
Management Effectiveness (Y)	3.89	0.63	High

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These results indicate that digital literacy and organizational culture have developed relatively well, whereas ICT infrastructure readiness remains a critical weakness that may constrain the implementation of the hybrid DDDM–AI management model.

Convergent validity was assessed by examining the Average Variance Extracted (AVE) values for each construct. All variables met the required threshold of AVE > 0.50 (Digital Literacy = 0.67; Infrastructure Readiness = 0.61; Organizational Culture = 0.69; Management Effectiveness = 0.72), indicating satisfactory convergent validity.

Reliability testing was conducted using Cronbach's Alpha and Composite Reliability (CR), as presented below:

Table 4. Instrument Validity and Reliability Testing

Variable	Cronbach's Alpha	CR	Interpretation
X_1 – Digital Literacy	0.894	0.917	Reliable
X_2 – Infrastructure Readiness	0.861	0.903	Reliable
X_3 – Organizational Culture	0.879	0.921	Reliable
Y – Management Effectiveness	0.903	0.934	Reliable

All values exceeded the minimum criteria of $\alpha > 0.70$ and CR > 0.70, confirming excellent internal consistency (Hair et al., 2019).

Structural Model Evaluation (Inner Model)

The coefficient of determination (R^2) and predictive relevance (Q^2) were used to evaluate the structural model.

Table 5. R-Square and Predictive Relevance

Endogenous Variable	R^2	Interpretation
School Management Effectiveness (Y)	0.714	Strong

An R^2 value of 0.714 indicates that 71.4% of the variance in management effectiveness is explained by digital literacy, infrastructure readiness, and organizational culture, while the remaining 28.6% is influenced by other factors.

The predictive relevance value ($Q^2 = 0.682$), which is greater than zero, confirms that the model has strong predictive capability.

Hypothesis testing was conducted using the bootstrapping procedure (5,000 resamples) in SmartPLS 4, with a significance level of $\alpha = 0.05$.

Table 6. Hypothesis Testing Results

Hypothesis	Path	β Coefficient	t-Statistic	p-Value	Result
H_1	Digital Literacy → Management Effectiveness	0.413	6.224	0.000	Significant
H_2	Infrastructure Readiness → Management Effectiveness	0.278	4.017	0.000	Significant
H_3	Organizational Culture →	0.311	5.466	0.000	Significant

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	Management Effectiveness				
H_4	$X_1 + X_2 + X_3 \rightarrow$ Management Effectiveness	–	–	$F = 64.82$ ($p < 0.001$)	Simultaneously Significant

The results indicate that all hypotheses were supported. Digital literacy exerted the strongest influence on management effectiveness, followed by organizational culture and infrastructure readiness.

Interpretation of Findings

The findings demonstrate that the digital literacy of principals and teachers plays the most dominant role ($\beta = 0.413$) in improving school management effectiveness. This result confirms the Technology Acceptance Model (TAM) proposed by Davis (1989), which emphasizes perceived usefulness and perceived ease of use as key predictors of technology adoption.

Organizational culture functions as a reinforcing mechanism for the adoption process. Schools characterized by collaborative and open cultures are better able to integrate AI systems and data-driven decision-making practices. Meanwhile, infrastructure readiness shows a comparatively lower direct effect ($\beta = 0.278$), indicating that the availability of technology alone is insufficient without adequate user literacy.

The proposed hybrid DDDM–AI management model demonstrates strong empirical effectiveness, with a Goodness of Fit (GoF) value of 0.706, exceeding the threshold of 0.36 and indicating a high-level model fit (Tenenhaus et al., 2005).

This paper provides a substantive and rigorous description of the functioning of hybrid data - driven decision-making (DDDM) and artificial intelligence (AI) management in the elementary school of Gorontalo. The empirical data show that the effective work of managers is not significantly dependent on the presence of digital systems, but is determined by the ability of the actors within schools to interpret data, organize efforts and maintain organizational learning. The statistical analysis is especially relevant because it demonstrates the order of influence, according to which digital literacy is the most powerful factor, then organizational culture has a reinforcing impact, and finally infrastructure readiness is an enabling condition. The work, therefore, goes beyond a shallow account of digital adoption in that the manner in which managerial efficacy is generated when technology is integrated into human judgment and institutional practice is clarified.

This excessive influence of digital literacy may be interpreted to mean that the school administration in digital environment is more reliant on the skill of leadership than the pure technological supply. Recent research supports this explanation and describes data literacy of principals as a versatile asset that involves estimating evidence, prioritization, and organization of group actions in the cause of school improvement, not mere use of digital apps (Lee et al., 2024). This point of view explains why the digital literacy in the current study has a greater impact compared to infrastructure preparedness. Schools can have platforms and devices, but management can only be productive when leaders and staff can transform available data into planning decisions, routines of monitoring, and the evaluation of reflection. In this regard, the proposed model has digital literacy playing the practical role of connecting information availability to the management action.

The meaning is also supported by the DDDM scholarship that separates data possession and data utilization. Ming (2024) argues that the challenges that educational leaders face are often

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met not due to the lack of data, but due to the underdevelopment of interpretative and decision abilities. The existing results are quite congruent with this claim; the schools which seem to be more successful may be those schools which are better equipped to use the data as a feedback to organizational adaptation instead of having more data. The conceptual orientation of the study is aligned to this opinion, as the effectiveness of management is associated with adaptation, responsiveness, and evidence-based decision making. The contribution made by this study thus goes beyond the statistical analysis to a conceptual plane and shows that hybrid management is successful when DDDM is implemented as an organizational activity at least not as an administrative reporting practice.

At the same time, the high role of the organizational culture proves that digital management is maintained by mutual norms and joint work rather than individual ability. This point can be identified as essential because even schools that are similar in terms of the technologies deployed can still have different rates of managerial effectiveness in case the internal culture of trust, collaboration, and readiness to change differ. This point of view is backed by empirical research on digital school culture and digital leadership in Indonesia that has shown that effective digital integration is based on change management, collaborative practices, and leadership that can bring school actors on a shared agenda (Purnomo et al., 2024; Hidayat et al., 2024). Considering these results, the organizational culture can be theoretized as the state, which allows digital literacy to go beyond individual capability and appear as an institutional one.

The relatively minor impact of infrastructure preparedness ought to be taken at face value. This does not mean that infrastructure is any less important in a practical sense, but that in itself, it cannot provide effective management unless it is accompanied by the literacy and cultural conditions necessary to use it. This interpretation is congruent with OECD studies on systemic digital education, which highlight that digital transformation is contingent on the interrelationship between tools, governance, and human actors as opposed to technological availability per se (OECD, 2023; OECD, 2025). The rationale applies to the AI element of the model as current research on AI in education stipulates that AI has the potential of supplementing administrative functions and decision-making but should not be allowed to substitute professional judgment with the output. The results of the study confirm a pragmatic perspective according to which AI plays the role in combination with data routines and institutional practice, whereas human interpretation is the key factor in managerial decisions.

The paper contains a contextual and a narrow argument concerning digital management reform in elementary education in Gorontalo. The first force that determines efficient hybrid DDDM and AI management is the digital literacy, followed by organizational culture, and finally infrastructure preparedness. This hierarchy is conceptually clear and operationally informative, because it will make the author focus on the development of capabilities and the institutions without downplaying the value of technological support. In this respect, the study still possesses the empirical nature, but it provides a more accurate understanding of why some schools are in a better position than others to implement digital systems into productive management practice.

Conclusion

The research supports the idea that human and organizational capacity is the central factor that determines the success of the hybrid data-driven decision making (DDDM) and artificial intelligence (AI)-based school management in elementary schools in Gorontalo and not the presence of technology per se. The results are a consistent finding that digital literacy is the most prevalent factor because it helps the school actors to make sense out of data, to convert

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information into action and to perform planning, monitoring, as well as evaluation in a more meaningful way. On the same note, organizational culture has a significant impact, as it is not the individuality that produces an effective digital management but the combination of routines, trustfulness, and the alliance to use information to make schools better. Although infrastructure preparedness is crucial, the difference it makes is the greatest when it enhances already existing capacities that the school is already operating.

Viewed in a broader perspective, the research has a significant implication towards learning and application of digital transformation in school management. The management strengthening that is based on hybrid DDDM and AI can not be the matter of presenting platforms, applications, or technical systems, but developing managerial competency and building an institutional environment that will be able to maintain the evidence-based practice. Based on this, the enhancement of digital literacy and the establishment of a positive organizational culture should be the priority of the improvement efforts, and the infrastructure should be sufficient and operational. With this integrative strategy, the digital systems will be able to go beyond the administrative applications and be a part of a more dynamic, thoughtful and productive management practice that is still based on the actual situation of the elementary schools.

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