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Digital Infrastructure and Leadership in Driving School Performance and Graduate Quality: Evidence from Indonesia

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ABSTRACT

This study examines the influence of digital infrastructure readiness and digital leadership on the implementation of school administration, academic outcomes, and the quality of madrasah graduates in Indonesia. This research utilised a quantitative approach and structural equation modelling (SEM) to conduct a survey of principals and teachers in various madrasahs throughout East Java Province. The results demonstrated that readiness in digital infrastructure and robust digital leadership significantly improved the effectiveness of SBM, thereby positively impacting school performance and the quality of graduates. This study emphasises the significance of investing in technology and cultivating digital leadership in madrasahs to enhance educational quality. The results underscore the necessity of collaboration among educational institutions, communities, and governmental bodies to advance the establishment of sustainable digital infrastructure. This study enhances the current literature by offering empirical data about the essential role of digital infrastructure and leadership in Islamic education in Indonesia.

Keywords: Digital Infrastructure, Digital Leadership, School-Based Management, School Performances, Graduate Quality
JFL Classifications: M12, I21, M15

1. INTRODUCTION

Education faces new challenges that require adaptation and innovation in school management and administration. As Islamic educational establishments, madrasahs in Indonesia play a significant role in producing a future workforce that is not only more knowledgeable about religion but also competitive in the domains of science and technology (Hanafi et al., 2021; Kosim et al., 2023). However, the obstacles faced by madrasahs in the context of educational modernization are not simple. One of the main challenges is how madrasahs can integrate technology and digitalization into the management and learning process without neglecting the core principles of education rooted in Islamic teachings within madrasahs (Chotimah et al., 2025; Fathullah et al., 2023). Moreover, madrasahs frequently encounter constraints regarding resources, particularly concerning infrastructure and management capabilities (Juhji et al., 2025; Sali and Marasigan, 2020). The current circumstances hinder the implementation of school-based management and digitisation strategies. Leadership that corresponds with digital innovations and adequate infrastructure can markedly improve the performance and quality of graduates in madrasahs (Haddade et al., 2024; Nurabadi et al., 2022).

The preparedness of the technology infrastructure in place is a crucial factor in facilitating the adoption of school-based management in madrasahs (Dormann et al., 2019). The digitisation of management and learning processes will face significant obstacles in the absence of adequate infrastructure (Rundel and Salemink, 2021; Shepherd and Taylor, 2019). Furthermore,

digital leadership is crucial in directing and overseeing digital transformation within the educational context, as noted by Tamar et al. (2022); and Trenerry et al. (2021). The establishment of school-based management strategies that are more successful is possible if there is strong leadership in the digital field, which is anticipated to lead to improvements in the performance of schools and the quality of graduates.

Earlier studies has demonstrated the crucial role of technological infrastructure preparedness in supporting the education sector's digital transition. Research by Olanrewaju et al. (2021) highlighted that the effective integration of technology in education is significantly contingent upon the preparedness of the current infrastructure, including internet connectivity, hardware, and software utilised. This research aligns with recent studies indicating that insufficient infrastructure will provide substantial challenges to the integration of technology in education (Male and Alhouti, 2017; Rubach and Lazarides, 2021). Conversely, digital leadership has been recognised as a crucial element in guiding technology transformation within educational institutions. Research by Lindqvist and Pettersson (2019) indicates that school leaders with digital competency can foster innovation and enhance the efficacy of school management. This is also supported by other studies showing that strong leadership in technology can improve school performance and facilitate technology-based learning (Corbett amd Spinello, 2020; Karakose et al., 2021; Suanpang and Thangchitcharoenkhul, 2021).

The current study gap indicates that comprehensive studies are required to comprehend the interplay between infrastructure readiness, digital leadership, and school-based administration within madrasahs. Madrasahs in Indonesia exhibit distinctive traits, particularly with their curriculum that integrates religious and secular knowledge, as well as the obstacles encountered related to resources and administration (Devi and Subiyantoro, 2021; Karim et al., 2025). Despite studies emphasising the significance of technology and digital leadership in education (Lindqvist and Pettersson, 2019; Maisyaroh et al., 2024), research particularly examining their impact on madrasah management and performance remains scarce. Furthermore, previous research has primarily focused on public schools (Juharyanto et al., 2021; Nurabadi et al., 2022; Peng, 2021), while studies examining madrasahs in relation to digitalisation and school management are very few. This highlights a gap in the literature that requires more focused research on madrasahs, especially concerning the effective integration of digitalisation while preserving the Islamic identity and values that are the foundation of these institutions.

This study augments the current knowledge by providing a comprehensive analysis of the influence of infrastructure readiness and digital leadership on the implementation of school-based management, academic performance, and graduate quality in madrasahs. The analysis offers new insights into how madrasahs adapt to the challenges of digitalisation, illustrating how these elements might be leveraged to improve educational quality. The report offers practical assistance for policymakers, school leaders, and other stakeholders in formulating strategies to effectively incorporate technology into management practices and educational processes. The findings not only enrich theoretical understanding but also offer concrete applications for improving the calibre of Indonesian Islamic education, particularly through the reinforcement of infrastructure and leadership capacity.

2. LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

2.1. Graduate Quality

Graduate quality (GQ) represents the ultimate outcome of educational processes and reflects the extent to which educational institutions successfully develop students' competencies, skills, and character to meet societal and labor market demands (Rohman et al., 2023; Timan et al., 2025). Contemporary perspectives emphasize that graduate quality extends beyond academic achievement to include critical thinking, problem-solving abilities, digital literacy, adaptability, and ethical values (Anwar and Saraih, 2024; Zhao et al., 2020). Such multidimensional capabilities position graduates as valuable human capital contributing to economic productivity and organizational competitiveness.

Educational management literature highlights that graduate quality is shaped by the effectiveness of organizational systems within schools (Lee et al., 2019; Sliwka et al., 2023). Institutional performance, leadership capacity, and resource availability are consistently identified as critical determinants of educational outcomes (Fomba et al., 2023; Haddade et al., 2024). Schools that demonstrate efficient management practices tend to produce graduates with stronger competencies and higher readiness to respond to real-world challenges. This relationship indicates that graduate quality reflects not only instructional processes but also the overall effectiveness of institutional governance and management. Modern education systems are required to equip students with digital competencies that enable them to function effectively in technology-driven environments (Aruleba and Jere, 2022; Rislan et al., 2025). Digital literacy, information processing skills, and the ability to utilize technological tools have become essential components of graduate outcomes (Tołwińska, 2021; Tomczyk et al., 2021). Educational institutions are therefore required to align their infrastructure, learning systems, and management practices with the demands of digital transformation to ensure the development of relevant competencies.

Leadership and governance mechanisms also play a decisive role in shaping graduate outcomes. Effective leadership promotes innovation, facilitates strategic decision-making, and supports the integration of technology into teaching and administrative processes (Nurabadi et al., 2022; Shepherd and Taylor, 2019). School-based management practices further enhance institutional responsiveness by enabling participatory decision-making and aligning educational strategies with local needs (Bandur et al., 2022; Szeto, 2020). Such governance approaches contribute to improved learning environments and ultimately lead to higher graduate quality (Ulfatin et al., 2020). A comprehensive understanding of graduate quality requires an integrative perspective that considers the interaction between technological readiness, leadership effectiveness, management systems, and

institutional performance. Graduate outcomes are produced through a systemic process where each organizational component contributes to the overall educational output. This perspective underscores that improving graduate quality cannot be achieved through isolated interventions but requires coordinated efforts across multiple dimensions of educational management.

2.2. Digital Infrastructure Readiness

Digital infrastructure readiness (IR) refers to the extent to which educational institutions possess adequate technological resources, including internet connectivity, hardware, software, and digital platforms that support administrative and instructional processes (Alhammadi et al., 2023; Rawal, 2024). The availability of reliable digital infrastructure forms the foundational basis for implementing technology-driven management systems and modern learning environments. Educational institutions require well-established digital systems to ensure efficiency, connectivity, and responsiveness in both academic and administrative functions (Mohammed et al., 2025). Existing literature consistently emphasizes that institutions equipped with sufficient technological resources demonstrate higher efficiency in handling administrative tasks, managing data, and coordinating stakeholders (Olanrewaju et al., 2021; Rundel and Salemink, 2021). Digital platforms facilitate real-time communication, improve access to information, and enhance transparency in decision-making processes (Demir et al., 2019). Such capabilities are essential for supporting decentralized governance systems, particularly those that rely on flexibility and institutional autonomy. The implementation of school-based management is strongly dependent on the availability of accurate information systems and effective communication channels (Al Nuaimi et al., 2023). Digital infrastructure enables schools to manage resources more effectively, monitor performance in real time, and respond promptly to changing demands. Strong infrastructure readiness therefore enhances the capacity of schools to implement participatory and decentralized management practices (Okoye et al., 2023; Saini et al., 2024).

Educational institutions that integrate technology into their operational and instructional processes tend to achieve higher levels of performance due to improved efficiency and innovation (Akram et al., 2022; Mohammed et al., 2025). Technology-supported learning environments provide broader access to educational resources, support interactive teaching methods, and increase student engagement. Administrative efficiency further allows educators to focus on instructional quality, thereby strengthening overall school performance (Dormann et al., 2019; Rawal, 2024). Graduate quality is closely associated with the technological environment in which learning takes place, access to digital infrastructure enables students to develop essential competencies such as digital literacy, critical thinking, and problem-solving skills (Pasi and Dhamak, 2025; Pozas and Letzel, 2023). Exposure to technology-rich environments prepares students to adapt to evolving labor market demands and enhances their competitiveness (Aas and Paulsen, 2019; Fathullah et al., 2023). These arguments indicate that digital infrastructure readiness functions as a fundamental driver of effective management, improved organizational performance, and enhanced graduate outcomes. The presence of adequate infrastructure supports not only internal processes but also the development of competencies required in contemporary education systems. Accordingly, the following hypotheses are formulated.

H_1: Digital infrastructure readiness has a direct effect on school-based management.

H_2: Digital infrastructure readiness has a direct effect on school performance.

H_3: Digital infrastructure readiness has a direct effect on graduate quality.

2.3. Digital Leadership

Digital leadership (DL) refers to the ability of leaders to strategically integrate digital technologies into organizational processes, foster innovation, and guide institutions through ongoing digital transformation (Antonopoulou et al., 2020; Peng, 2021). Leadership in the digital era extends beyond traditional managerial functions by requiring technological awareness, adaptive capacity, and a forward-looking vision (Al Nuaimi et al., 2023; Tamar et al., 2022). Scholarly evidence indicates that digital leadership plays a pivotal role in shaping organizational transformation, leaders who possess strong digital competencies are more capable of encouraging innovation, promoting collaboration, and facilitating the adoption of technology in educational environments (Karakose et al., 2021; Lindqvist and Pettersson, 2019). The effectiveness of school-based management is closely linked to leadership practices that support participatory and data-driven governance (Al Nuaimi et al., 2023; Aquino et al., 2021). School-based management requires leaders who can coordinate stakeholders, manage resources efficiently, and make informed decisions. Leaders who effectively utilize digital systems are better positioned to strengthen participatory decision-making and institutional accountability (Hsieh et al., 2025; Nurabadi et al., 2022).

Organizational performance within educational institutions is also influenced by leadership that integrates digital technologies into both instructional and administrative domains (Dormann et al., 2019; Nurabadi et al., 2021). Leaders who actively promote technology use can improve operational efficiency, enhance monitoring and evaluation systems, and support innovative teaching practices (Corbett and Spinello, 2020; Suryadi et al., 2024). These improvements contribute to better academic outcomes, stronger institutional performance, and more effective organizational processes. Graduate quality is further shaped by leadership that prioritizes digital transformation. Educational institutions led by digitally competent leaders are more capable of preparing students for the demands of the digital economy (Anwar and Saraih, 2024; Umah et al., 2023). Leadership that emphasizes innovation and continuous improvement ultimately contributes to higher graduate quality. Hence, the following hypotheses are proposed.

H_4: Digital leadership has a direct effect on school-based management.

H_5: Digital leadership has a direct effect on school performance.

H_6: Digital leadership has a direct effect on graduate quality.

2.4. School-Based Management

School-based management (SBM) refers to a decentralized governance approach that grants schools greater autonomy in managing resources, decision-making processes, and educational

strategies to improve institutional effectiveness (Bandur, 2012b; Bandur et al., 2022). This management model emphasizes participation, accountability, and flexibility, allowing schools to adapt policies and practices according to local needs and contextual conditions. SBM shifts authority from central administration to the school level, enabling stakeholders such as principals, teachers, and communities to actively engage in organizational processes (Khilji et al., 2022; Toh et al., 2016). Institutions that implement SBM are better positioned to align educational programs with student needs, allocate resources efficiently, and foster collaborative decision-making (Reynolds and Mckimm, 2020; Ulfatin et al., 2020). Participatory governance structures create a sense of ownership among stakeholders, which contributes to improved commitment and institutional performance (Timan et al., 2026). Greater autonomy also allows schools to innovate in curriculum design, teaching methods, and resource management (Latief et al., 2021). Empirical evidence suggests that SBM has a direct impact on organizational performance in educational institutions, schools that effectively implement decentralized management practices tend to demonstrate higher levels of efficiency, improved academic outcomes, and stronger institutional performance (Amiruddin et al., 2023; Donkoh et al., 2023). Autonomy in decision-making enables schools to respond more quickly to challenges, optimize resource utilization, and implement context-specific strategies.

Graduate quality is also influenced by the effectiveness of school-based management, participatory and decentralized management practices create learning environments that are more adaptive, student-centered, and aligned with real-world demands (Fullan and Watson, 2000; Khalid et al., 2023). Improved management practices also support teacher development and instructional quality, which ultimately contribute to better graduate outcomes (Juharyanto et al., 2021; Shulhan, 2018). The role of SBM as a strategic mechanism becomes particularly important in linking organizational inputs with educational outputs. Schools that successfully integrate participatory governance, efficient resource management, and contextual decision-making are more likely to achieve higher performance and produce graduates with stronger competencies. Therefore, the hypotheses are stated as follows.

H_7: School-based management has a direct effect on school performance.

H_8: School-based management has a direct effect on graduate quality.

2.5. School Performance

School performance (SP) reflects the overall effectiveness of educational institutions in achieving their academic and organizational objectives (Bendikson et al., 2012; Suanpang and Thangchitcharoenkhul, 2021). Performance is typically assessed through a combination of academic outcomes, operational efficiency, institutional effectiveness, and stakeholder satisfaction. Educational management literature views school performance as a key indicator of how well resources, leadership, and management practices are utilized to produce desired outcomes (Adhikary, 2021; Sliwka et al., 2023). A strong body of research highlights that school performance is closely associated with the quality of educational processes and institutional management, schools that demonstrate high levels of organizational effectiveness tend to provide better learning environments, implement more effective instructional strategies, and achieve superior student outcomes (Bouranta et al., 2021; Juharyanto et al., 2023). Effective performance reflects the ability of schools to align internal processes with external demands, including curriculum standards, technological advancements, and labor market expectations.

Performance within educational institutions also represents the cumulative result of various organizational factors, including leadership effectiveness, management systems, and resource availability (Dormann et al., 2019; Heystek and Emekako, 2020). Schools that effectively integrate these elements are more capable of delivering high-quality education and sustaining continuous improvement. Graduate quality is directly influenced by the level of school performance. High-performing schools create structured and supportive learning environments that enhance student engagement, knowledge acquisition, and skill development (Barret et al., 2019; Ugarte et al., 2022). Effective instructional practices, combined with efficient administrative systems, contribute to the development of competencies required in contemporary society. Students in high-performing institutions are more likely to achieve academic success and acquire the skills necessary for future professional and social roles (Rislan et al., 2025; Rohmat et al., 2024). The relationship between school performance and graduate quality highlights the importance of organizational effectiveness in shaping educational outcomes. Strong institutional performance ensures that learning processes are delivered efficiently and consistently, leading to improved student achievement and overall graduate competence (Karim et al., 2025; Oktar, 2022). School performance therefore acts as a critical determinant of educational success and serves as a direct pathway through which management practices influence graduate quality. Thus, the following hypothesis is proposed.

H_9: School performance has a direct effect on graduate quality.

3. METHODS

3.1. Design

This study employs a quantitative methodology utilising structural equation modelling (SEM) to systematically analyse the relationships among the variables under examination. This study involved a cross-sectional survey of teachers and administrators in Islamic schools in the East Java region of Indonesia. A structured online questionnaire was created to fulfil the research goals. This study encompassed several primary variables: Infrastructure readiness (IR), digital leadership (DL), school-based management (SBM), school performance (SP), and graduate quality (GQ).

3.2. Participants and Research Instruments

Various Islamic schools in East Java Province, Indonesia were represented by principals and instructors who participated in this investigation. The preference sampling method was employed to obtain the sample. To prevent bias and inaccuracy, Collins et al. (2016) recommended that the optimal sample size be at least 200. Subsequently, Principals and Teachers were provided with over 400 online questionnaires via email and WhatsApp. Respondents were informed of the study's objective and the importance of their responses to guarantee the integrity of the study. The respondent

was advised that there was no definitive correct or incorrect response, and that all alternatives were valued. Furthermore, responses were provided anonymously, and participation in the survey was completely voluntary (Podsakoff et al., 2023). There were 400 surveys distributed, and the response rate was 60.75%. This indicates that 243 surveys were completed and utilised for data analysis.

This research employed questions modified from those used by earlier scholars, and the questionnaire distributed was of a closed-ended format. A total of forty-eight question items were distributed for responses. Responses were measured using a five-point scale, ranging from "always" (5) to "never" (1). Every construct piece is rooted in numerous previous investigations that align with the study problem. The IR measurement scale underwent a modification, incorporating nine items aligned with the indicators established by Aas and Paulsen (2019); and Vidanagama and Karunathilake (2021). The eleven-item questionnaire designed to measure DL was revised in accordance with the markers identified in the studies by Nurabadi et al. (2022); and Uğur and Koç (2019). The SBM measurement questionnaire, consisting of 10 items, was revised in accordance with the indicators outlined by Bandur (2012b); and Ulfatin et al. (2020). The questionnaire designed to assess SP included eight items and was refined using indicators established by Bendikson et al. (2012); and Juharyanto et al. (2023). The validity of the instrument was evaluated using the content validity index (CVI). Five scholars in educational administration and digital leadership were tasked with assessing the pertinence of each item to the construct under examination. The instrument exhibited exceptional content validity, as evidenced by the Scale-level Content Validity Index (S-CVI) of 0.89 and the Item-level content validity index (I-CVI) values spanning from 0.82 to 0.95 (Polit and Beck, 2006). The reliability evaluation of the instruments, which utilised Cronbach's Alpha, validated their internal consistency, yielding values exceeding 0.70 for each construct (Nunnaly and Bernstein, 1994).

3.3. Statistical Analysis

The data was analysed using SEM procedures, utilising AMOS 24.0 software to enhance accuracy. Structural equation modelling (SEM) was employed to evaluate the validity of the proposed model and to analyse the interactions and effects among the research variables. Three distinct phases comprise the data analysis. Initially, AMOS 24.0 was employed to conduct normality and outlier testing. The model's reliability and validity were assessed using confirmatory factor analysis (CFA). The conditions for achieving convergent validity are that the factor loadings must be larger than 0.70, the average variance extracted (AVE) must be >0.50, and constructs must be considered to be dependent when the composite reliability (CR) is >0.70 (Awang, 2014). The criteria provided by Whittaker and Schumacker (2022); and Kline (2015) were adopted to evaluate the overall adequacy of the measurement model, with reference to indices such as CMIN/df, P-value, RMSEA, SRMR, TLI, AGFI, CFI, and GFI. In addition to these fit measures, discriminant validity was assessed based on the procedure proposed by Rönkkö and Cho (2020), which compares the square root of the AVE against the correlation coefficients of the constructs. The third phase required a comprehensive review of the structural model in order to verify that the presented hypothesis was correct (Collier, 2020).

4. RESULTS

4.1. Normality and Outlier Test

The data's feasibility for SEM analysis was verified through a comprehensive assumption testing process that included normality and outlier examinations. The results of the normality test showed that there were no univariate normality issues because the critical ratio (c.r.) values for skewness and kurtosis of all indicators were less than the ± 2.58 cutoff. The c.r value of multivariate kurtosis was found to be 2.37, indicating that it falls within the threshold of acceptability suggested by Byrne (2016). These findings confirm that the data distribution satisfies the normality requirements at both the univariate and multivariate levels. Referring Blunch (2013) recommendations, the subsequent outlier test compared the mahalanobis distance (MD) values to the Chi-square reference. The Chi-square cutoff of 374.91 was not met by the highest MD value obtained, 261.87, which suggests that there were no significant multivariate anomalies. The findings suggest that the dataset is devoid of normality or outlier concerns, which is essential for performing further SEM analysis with the dataset.

4.2. Confirmatory Factor Analysis

The measuring model's validity across all observed constructs was tested using confirmatory factor analysis (CFA). The goodness-of-fit indices reveal that the model meets the requirements outlined by Whittaker and Schumacker (2022); and Kline (2015). Based on Table 1, the findings reveal that the model exhibits a satisfactory fit, as evidenced by a P = 0.06, suggesting no significant disparity between the model and the data, and a CMIN/df of 1.98, which is below the acceptable threshold of 3.00. The model's adequacy is robustly evidenced by a CFI of 0.93, an AGFI of 0.91, and a GFI of 0.91, all exceeding the 0.90 threshold. Supporting indices corroborate this conclusion: The SRMR value of 0.07 and RMSEA value of 0.07, both below 0.08, indicate a small error level, while the TLI score of 0.92, nearing the ideal score of 1, underscores the model's robustness. Collectively, these indicators affirm the measurement model and warrant the continuation of following investigations with assurance in its validity and reliability.

The constructs' reliability was initially assessed using composite reliability (CR). The analysis indicated that all constructs above the specified minimum level of 0.70, consistent with the criteria proposed by Hair et al. (2016). The digital leadership (DL) construct achieved a CR value of 0.944, and the graduate quality (GQ) construct registered 0.910, both indicating exceptional dependability. Upon verifying reliability, convergent validity was subsequently evaluated by analysing the factor loadings of each indicator. The results shown in Table 2 demonstrate that all factor loadings exceed 0.70, hence substantiating the validity of the constructs. The findings demonstrate a significant correlation between the items and their respective constructs, consistently measuring the intended notion and satisfying the criteria for convergent validity.

The analysis of average variance extracted (AVE) enhanced the convergent validity in this study. The findings indicated that

AQ3 **Table 1: Fit indices assesment**

Indices	CFI	TLI	RMSEA	P	CMIN/df	AGFI	GFI	SRMR
Calculated	0.93	0.92	0.07	0.06	1.98	0.91	0.91	0.07
Cut of value	>0.90	>0.90	<0.08	>0.05	<3.00	>0.90	>0.90	<0.08
Interpretation	Good	Good	Good	Good	Good	Good	Good	Good

Table 2: Convergent validity assesment

Variable	Encode	Loading	CR	AVE
Infrastructure readiness (IR)	IR1-IR9	0.703-0.861	0.902	0.639
Digital leadership (DL)	DL1-DL11	0.792-0.914	0.944	0.717
School-based management (SBM)	SBM1-SBM10	0.735-0.880	0.918	0.672
School performance (SP)	SP1-SP8	0.767-0.866	0.931	0.698
Graduate quality (GQ)	GQ1-GQ10	0.719-0.892	0.910	0.651

Table 3: Assesment of discriminant validity

Variable	IR	DL	SBM	SP	GQ
Infrastructure readiness (IR)	**0.799**				
Digital leadership (DL)	0.408	**0.847**			
School-based management (SBM)	0.268	0.155	**0.820**		
School performance (SP)	0.317	0.463	0.310	**0.835**	
Graduate quality (GQ)	0.292	0.285	0.392	0.422	**0.807**

Table 4: Hypothesis testing summaries

Hypothesis	Path	Significane (P)	β	Interpretation
H_1	IR→SBM	0.01	0.18	Confirmed
H_2	IR→SP	0.00	0.29	Confirmed
H_3	IR→GQ	0.00	0.32	Confirmed
H_4	DL→SBM	0.00	0.39	Confirmed
H_5	DL→SP	0.00	0.28	Confirmed
H_6	DL→GQ	0.02	0.21	Confirmed
H_7	SBM→SP	0.00	0.42	Confirmed
H_8	SBM→GQ	0.00	0.30	Confirmed
H_9	SP→GQ	0.00	0.34	Confirmed

all constructs attained AVE values beyond the 0.50 threshold proposed by Bagozzi and Yi (1988), so affirming that the variance explained is predominantly derived from the intended indicators rather than measurement error. Infrastructure readiness (IR) and School-based management (SBM) exhibited AVE values of 0.639 and 0.672, respectively, indicating that over 50% of the variance in these categories is explained by their indicators. The results of factor loadings and composite reliability (CR) collectively furnish compelling evidence of convergent validity, so establishing a robust basis for further model interpretation.

Discriminant validity is essential for verifying that the constructs in a measurement model are truly distinct. Bagozzi and Yi (1988) assert that each construct must be distinguishable by its specific indicators, however Hair et al. (2016) highlight that the correlation between constructs should not surpass the square root of their respective AVE values. The findings of this study, presented in Table 3, confirm that the square root of the AVE for each construct is greater than the correlations with other constructs. For instance, the digital leadership construct recorded a square root of AVE of 0.847, which surpasses its correlations with school-based management (0.155) and school performance (0.463). These findings confirm that the constructs exhibit a stronger correlation with their own indicators than with external factors, hence substantiating their discriminant validity. The confirmation of this validity enhances the measuring model, guaranteeing that the constructs accurately represent the unique notions outlined in the study.

4.3. Evaluation of Structural Model

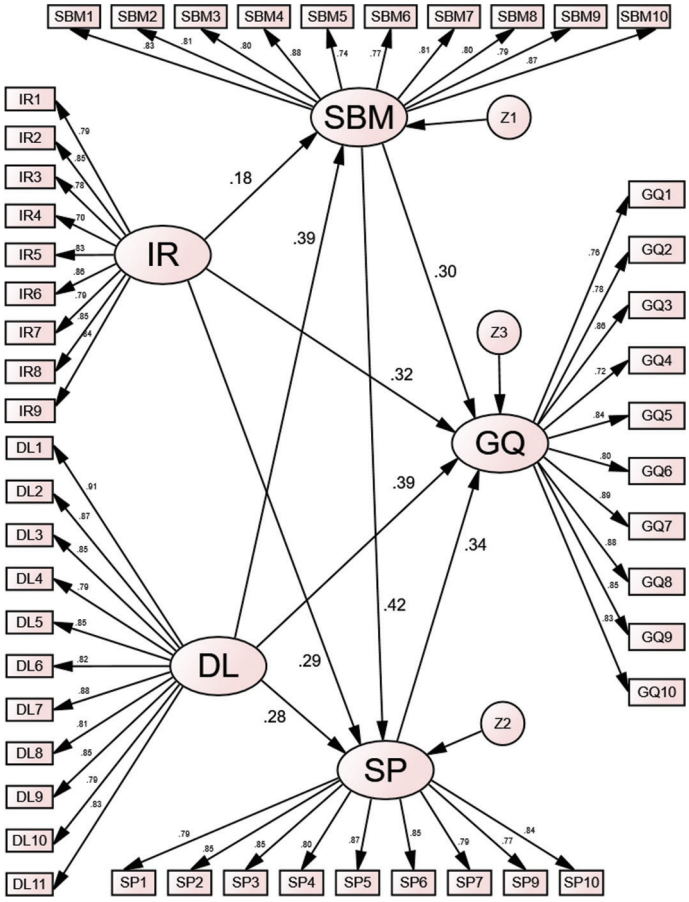
The findings of hypothesis testing conducted with AMOS software yield robust empirical evidence concerning the interconnections among infrastructure readiness (IR), digital leadership (DL), school-based management (SBM), school performance (SP), and graduate quality (GQ) in Islamic-based educational institutions (madrasah). Each path coefficient was using the beta (β) value to determine the effect size and the P-value to establish statistical significance (Figure 1, and Table 4). All proposed hypotheses were supported with $P < 0.05$, confirming the robustness of the structural model. Specifically, IR significantly influenced SBM (H_1: $P = 0.01$, $\beta = 0.18$), SP (H_2: $P = 0.00$, $\beta = 0.29$), and GQ (H_3: $P = 0.00$, $\beta = 0.32$), emphasizing that well-prepared infrastructure enhances both managerial practices and learning outcomes. DL also demonstrated a strong positive impact across the model, influencing SBM (H_4: $P = 0.00$, $\beta = 0.39$), SP (H_5: $P = 0.00$, $\beta = 0.28$), and GQ (H_6: $P = 0.02$, $\beta = 0.21$). Among the tested paths, the most dominant effect was found in the relationship between SBM and SP (H_7: $P = 0.00$, $\beta = 0.42$), which highlights the pivotal role of effective school-based management in boosting institutional performance.

Furthermore, SBM significantly influenced GQ (H_8: $P = 0.00$, $\beta = 0.30$), indicating that participative and responsible school administration leads to enhanced student outcomes. Ultimately, SP demonstrated a beneficial effect on GQ (H_9: $P = 0.00$, $\beta = 0.34$), confirming that the overall performance of schools directly influences the quality of graduates from madrasah. These findings robustly endorse the proposed theoretical paradigm, which identifies IR and DL as essential components that fortify SBM, subsequently improving SP, and ultimately GQ. The acceptance of all hypotheses signifies that the linkages among these constructs are both theoretically sound and empirically substantiated within the framework of Islamic-based education. The importance of β values across all pathways demonstrates that while IR and DL directly influence SP and GQ, their most substantial effect is on the SBM variable, highlighting the necessity of decentralised and participatory school governance.

5. DISCUSSION

This study demonstrates the substantial influence of digital infrastructure readiness (IR) and digital leadership (DL) on

Figure 1: Structural equation modelling results



school-based management (SBM), school performance (SP), and graduate quality (GQ) inside Islamic educational institutions. Infrastructure, encompassing physical buildings, information technology, and ancillary resources, is an essential prerequisite for the effective execution of school-based management (Vidanagama and Karunathilake, 2021). This discovery corresponds with the findings by Barret et al. (2019), which asserts that the efficacy of school-based management is predominantly influenced by sufficient facilities. The presence of representative classrooms, internet connectivity, laboratories, and digital administrative systems constitutes the primary foundations for principals and teachers in executing their planning, organising, implementing, and supervising duties (Tołwińska, 2021). This study also reveals that IR affects SP. Madrasahs possessing sufficient infrastructure typically exhibit superior performance in both academic and non-academic domains (Sutrisno et al., 2023). This aligns with the findings of Fomba et al. (2023), which indicate that educational infrastructure is intricately linked to enhancing the quality of learning and institutional performance. The use of contemporary facilities enables educators to more readily adopt technology-driven instruction, enhances administrative efficiency, and fosters a more productive work environment (Akram et al., 2022; Haddade et al., 2024).

IR has been demonstrated to affect GQ; madrasa graduates with sufficient infrastructure have more enriching learning experiences that align with contemporary requirements (Ahmed and Chowdhury, 2025; Mahsusi et al., 2024). Numerous studies indicate that access to technology resources is essential for enhancing students' digital literacy and providing them with 21st-century skills (Fathullah et al., 2023; Rislan et al., 2025). The data suggest that the quality of graduates is influenced by both curricular and pedagogical elements, as well as the infrastructural support present in the educational setting. Robust infrastructure preparedness enhances the learning process, making it more effective, innovative, and responsive to student requirements (Rosyadi et al., 2023). The enhancement of graduation quality in madrasas results from a synergy between infrastructural preparedness and effective instructional methodologies.

This study's empirical evidence demonstrates that digital leadership significantly influences SBM. The digital leadership exhibited by madrasah principals promotes the integration of technology in decision-making, communication, and resource management (Said and Sharif, 2023). This discovery corresponds with Corbett and Spinello (2020), who underscored that digital leadership is a crucial element in expediting educational organisations' adaption to digital transformation. Principals possessing strong digital literacy can enhance the transparency, adaptability, and participatory nature of school-based management (SBM) (Assalihee and Boonsuk, 2023; Latief et al., 2021). Digital leadership fosters a collaborative work culture by engaging all stakeholders in the school administration process. This leadership approach equips madrasahs to effectively address the challenges of the digital age, which prioritises agility, transparency, and responsibility (Suryadi et al., 2024).

Madrasah principals who adopt digital leadership can enhance the use of technology in the educational process. This leadership implementation enhances the efficacy of data-driven monitoring and evaluation (Antonopoulou et al., 2020). This empirical evidence corroborates the findings of Umah et al. (2023), which assert that digital leaders enhance organisational success via innovation and technology use. Madrasahs exhibiting a digital leadership style display significant adaptability to change. This condition fosters innovation in multiple facets of school administration. The efficient and purposeful application of technology results in significant enhancements in the quality of educational services (Tambak and Sukenti, 2025). Further research results show that DL has an influence on GQ. Digital leadership encourages the integration of technology into the curriculum and creates an innovative learning culture (Alazmi and Bush, 2024). This research aligns with various research findings that state that student readiness to confront global challenges is strongly influenced by the role of digital leadership (Mahsusi et al., 2024; Umah et al., 2023). Graduates of madrasahs cultivated through digital leadership practices exhibit strong academic competencies and 21st-century skills, while steadfastly adhering to Islamic values, ensuring that their quality is not only intellectually exceptional but also character-driven (Anwar and Saraih, 2024; Rohman et al., 2023).

This study shows that SBM has a significant influence on SP, through the autonomy granted to madrasas in managing resources, which has been proven to increase the effectiveness of education delivery (Amiruddin et al., 2023; Ugarte et al., 2022). Curriculum management tailored to local needs provides flexibility for schools to innovate (Mustofa et al., 2023). Community participation

in the educational process strengthens the accountability and transparency of institutions (Narindro et al., 2021). This condition has implications for improving madrasah academic and non-academic performance (Bandur et al., 2022; Haddade et al., 2024). These findings are consistent with the results of research by Donkoh et al. (2023) which explains that school-based management encourages organizational effectiveness because decisions are more relevant to the local context. Madrasah performance becomes more adaptive to changes in the educational environment. Improvements in the quality of educational services are also increasingly evident due to the increased independence in decision-making (Johari et al., 2018; Ulfatin et al., 2020). SBM not only contributes to SP but also impacts GQ. Participatory management enables a more contextual learning process and is tailored to student needs. Research by Bandur (2012a) in Indonesia supports this by confirming that consistent implementation of SBM can improve graduate quality. Improving the quality of teachers and education personnel is also more focused because there is room to determine appropriate professional development programs (Khalid et al., 2023). Madrasah graduates formed through this management system not only excel academically but also maintain relevance to current developments (Karim et al., 2025; Oktar, 2022).

Optimal school performance reflects the effectiveness of a well-organized learning process (Bouranta et al., 2021). Research by Rislan et al. (2025) confirms that graduate quality is a direct outcome of madrasah performance, as relevant to the findings of this study. High-performing madrasahs produce academically superior graduates, complemented by adequate social skills (Rohmat et al., 2024). 21st-century skills are also developed through adaptive school performance. Overall, research findings demonstrate a close relationship between variables within the madrasah education ecosystem. Infrastructure serves as the primary foundation for a successful educational process (Barret et al., 2019). Digital leadership serves as a driving force that ensures effective technology integration (Garcia et al., 2019). SBM serves as a management framework that ensures transparency and participation (Khilji et al., 2022). SP is an indicator of the achievements of educational organizations which is shown through GQ as the final output that reflects the overall quality of the madrasah education process (Alam, 2025; Sulhan and Hakim, 2023).

6. CONCLUSION

This study provides evidence that both digital infrastructure readiness and digital leadership significantly influence the implementation of school-based management, school performance, and graduate quality within madrasahs. Institutions with adequate infrastructure exhibit enhanced operational management, while strong digital leadership promotes technology integration and bolsters communication between educators and students. The interplay of these factors fosters increased management efficiency and superior educational results. Furthermore, the results indicate that madrasahs with effective school-based management and substantial infrastructure are more adept at producing graduates who are adequately prepared to fulfil workforce requirements, especially in the field of information and communication technology. The implications of these findings extend to education policy, especially in the digitalization agenda of Islamic schools. Prioritizing investment in digital infrastructure development is essential to strengthen management processes and enhance the overall quality of education. Enhancing the digital leadership capabilities of administrators and teachers should be a primary strategy to ensure effective technology integration in the teaching and learning process. This goal can be achieved through systematic training and continuous professional development programs. At the same time, fostering collaboration among government institutions, school administrators, and local communities emerges as a practical step to ensure sustainable development and maintenance of digital infrastructure in madrasahs, thereby supporting their long-term progress in the digital era.

This work offers significant insights; nonetheless, certain limitations must be acknowledged. This study exclusively examines madrasahs in East Java Province, hence the findings may not be entirely applicable to madrasahs in other parts of Indonesia with distinct characteristics and issues. Second, this study used a cross-sectional approach, so it could not explore long-term changes and dynamics in the implementation of digitalization in madrasahs. Furthermore, the survey method used may have limitations in capturing the nuances and complexities of respondents' experiences related to digitalization and school management. Based on these limitations, for future research, it is recommended that similar studies be conducted in various regions in Indonesia to test whether these findings are consistent across the country. Longitudinal study can yield profound insights into the evolution of digital infrastructure and leadership preparedness, as well as their impact on school performance and graduate quality over time. A more thorough understanding of the potential and challenges faced by madrasahs in the digital era can be achieved by combining qualitative methodologies, specifically in-depth interviews and case studies, with quantitative research. Subsequent research may also consider incorporating variables like organizational culture and the extent of government support to better capture the dynamics of digital transformation in Islamic schools.

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