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An Analysis of Determinant Factors in the Management of Madrasah Ibtidaiyah in the Archipelago Region

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Abstract

This study aims to identify the dominant factors influencing the management of madrasah ibtidaiyah in the archipelago. The research employs a quantitative approach with an ex post facto design, utilizing accreditation data from Madrasah Ibtidaiyah. Twenty-nine madrasahs were selected as samples using purposive sampling, based on the criterion of being accredited between 2021 and 2023 in Maluku Province. Principal Component Analysis (PCA) was applied to analyze analyze the data. The findings reveal that four principal components were identified out of 13 initial components, cumulatively accounting for 83.3% of the total variance. This sample confirms the model's reliability in explaining madrasah management in the archipelago. These four principal components are: (1) Strategic leadership and madrasah quality assurance (64.9%), (2) Madrasah resource management (7.4%), (3) A conducive madrasah environment (6.3%), and (4) Partnership synergy with madrasah resources (4.7%). Further analysis indicates that strategic leadership and quality assurance exert the most significant influence, which is crucial in ensuring effective Madrasah management and the sustainability of educational quality in the archipelago. The implications of this study suggest that to enhance madrasah management effectiveness, madrasah leaders should reinforce internal quality assurance systems, optimize resource management, establish a conducive learning environment, and foster stronger partnerships with the community and other stakeholders. These findings provide a basis for formulating education policies that are more inclusive and adaptable to the geographical conditions of the archipelago, enabling it to compete effectively.

Kata kunci:
Madrasah Ibtidaiyah; Manajemen Madrasah; Kepemimpinan strategis; Penjaminan mutu; Analisis Komponen Utama (Principal Component Analysis/PCA)

Abstrak

Penelitian ini bertujuan untuk mengidentifikasi faktor-faktor dominan yang memengaruhi manajemen madrasah ibtidaiyah di wilayah kepulauan. Penelitian ini merupakan penelitian kuantitatif dengan pendekatan ex post facto dari data akreditasi madrasah ibtidaiyah. Sebanyak 29 madrasah dipilih sebagai sampel secara purposive sampling dengan kriteria merupakan madrasah yang telah diakreditasi antara tahun 2021 hingga 2023 di Provinsi Maluku. Principal Component Analysis digunakan untuk melakukan analisis data penelitian. Hasil penelitian menunjukkan bahwa dari 13 faktor/komponen berhasil direduksi menjadi empat komponen utama dengan total proporsi varian kumulatif sebesar 83.3%, yang menunjukkan keandalan model dalam menjelaskan manajemen madrasah di wilayah kepulauan. Keempat komponen utama tersebut, meliputi: 1) Kepemimpinan strategis dan penjaminan mutu madrasah (64,9%), 2) Pengelolaan sumber daya madrasah (7,4%), 3) Lingkungan madrasah yang kondusif (6,3%), dan 4) Sinergi kemitraan dengan sumber daya madrasah (4,7%). Analisis lebih lanjut menunjukkan bahwa kepemimpinan strategis dan penjaminan mutu madrasah memiliki pengaruh dominan dibandingkan faktor lainnya, dengan kontribusi terbesar dalam menjamin efektivitas manajemen madrasah dan keberlanjutan mutu pendidikan di wilayah kepulauan. Hasil penelitian ini mengimplikasikan bahwa untuk meningkatkan efektivitas manajemen madrasah, pemimpin madrasah perlu memperkuat sistem penjaminan mutu internal, pengelolaan sumber daya madrasah secara optimal, menciptakan

lingkungan belajar yang kondusif, serta memperluas sinergi kemitraan dengan masyarakat dan pemangku kepentingan lainnya. Temuan ini memberikan dasar bagi perumusan kebijakan pendidikan yang lebih inklusif dan adaptif terhadap kondisi geografis nusantara yang mampu bersaing dan berdaya saing.

INTRODUCTION

Sustainable educational development is highly dependent on the quality of school and madrasah management, particularly in remote and archipelagic regions. One of the main challenges in Indonesia's education system is the disparity in the quality of educational services between urban and rural areas. (Donkoh et al., 2023; Pambudi & Harjanto, 2020). This gap stems from various factors, including limited access to educational resources, low teacher competence, and inadequate infrastructure. (Rakhmani & Sakhiyya, 2024; Rawal, 2024; Yu et al., 2024). According to the 2021 report by the National Accreditation Board for Early Childhood Education, Primary Education, and Secondary Education, most madrasahs in Maluku Province still hold low accreditation ratings or remain unaccredited, reflecting the weak educational management in the region. (BAN S/M Provinsi Maluku, 2021)Therefore, research is needed to identify the factors affecting madrasah management quality and provide more targeted recommendations for improving educational services in archipelagic regions.

Several previous studies have examined issues related to the quality of education in archipelagic and remote areas. The main challenges in these regions include the low professional competence of teachers, limited welfare provisions for educators, and a lack of learning support facilities. (Huda, 2016; Rawal, 2024; Wakano et al., 2024). Meanwhile, Maesaroh (2018) and Moeis (2022) The low relevance of education to the job market further exacerbates the competence gap among madrasah graduates in rural areas. Furthermore, the study by Symaco & Bustos (2022) Emphasises the importance of madrasah management in maintaining sustainable education quality in archipelagic regions. However, this study did not specifically examine the factors influencing madrasah performance. Thus, there remains a need for a more in-depth understanding of the critical aspects of madrasah management that directly impact the quality of educational services in archipelagic regions such as Maluku.

Most prior research has focused on the availability of educational resources and teacher welfare without specifically exploring the key managerial factors that contribute most to improving education quality in madrasahs. (Kabwos et al., 2020; Ongere & Ogochi, 2023; Skinner et al., 2021). The study by Bahar et al. (2021) and Pambudi & Harjanto (2020) It has been revealed that many educational institutions in Sulawesi, Maluku, Nusa Tenggara, and Papua fall below the National Education Standards (NES or SNP). However, the study did not explicitly outline the factors responsible for variations in madrasah performance. (El Widdah, 2022; Juhaeni et al., 2021; Nuraeni et al., 2022; Tambrin et al., 2021). Additionally, much of the existing research is concentrated on educational contexts in Java, while archipelagic regions such as Maluku remain underexplored. This study addresses these gaps by identifying the dominant factors in madrasah management, particularly in *Madrasah Ibtidaiyah* (MI) in Maluku Province that most significantly contribute to the quality of educational services, using a Principal Component Analysis (PCA) approach.

This study employs Principal Component Analysis (PCA) as an analytical method to reduce various madrasah management factors into a set of principal components that substantially influence educational quality. PCA is a widely used statistical technique across multiple disciplines

for identifying key patterns within complex datasets (Liu et al., 2023; Nurhayati et al., 2022; Ünel & Yalpir, 2019). By adopting this approach, the study aims to provide a structured mapping of the key factors in madrasah management in Maluku, serving as a foundation for data-driven education policy formulation aimed at enhancing quality.

Building on the identified research gaps, this study aims to determine the dominant factors influencing MI management in the Maluku archipelago. This research is expected to make both theoretical and practical contributions, enriching the literature on education management in archipelagic contexts while offering valuable insights for education policymakers and madrasah administrators in devising effective strategies to enhance the quality of educational services. The findings of this study will not only help address the challenges of madrasah management in Maluku Province but also serve as a potential model for managing madrasah education in other archipelagic regions across Indonesia.

RESEARCH METHODS

This study aims to identify the primary factors influencing the management of myocardial infarction (MI) in Maluku. As proposed by Isaac and Michael, the approach adopts a quantitative design with an ex post facto design. (1971)This method was selected because the study relies on preexisting data that the researcher has not manipulated. This allows for an analysis of cause-and-effect relationships based on prior assessments.

The study was conducted over six months and involved a research population of 141 MIs in Maluku Province. A total of 29 MIs were selected as research samples through purposive sampling based on the criterion that the madrasahs had been accredited by the National Accreditation Board for Early Childhood Education, Primary Education, and Secondary Education of Maluku Province between 2021 and 2023. The research sample includes MIs with various accreditation ratings, A, B, C, and non-accredited, to ensure that the study provides a comprehensive picture of the management factors affecting MI performance. The demographic characteristics of the study sample are presented in Table 1.

Table.1 Research Demographics

Characteristic		Frequency (n=29)	Percentage (%)
Regency/City	Ambon	3	10.34
	Tual	1	3.45
	Buru	1	3.45
	Kepulauan Aru	1	3.45
	Maluku Tengah	6	20.69
	Maluku Tenggara	1	3.45
	Maluku Tenggara Barat	1	3.45
	Seram Bagian Barat	11	37.93
	Seram Bagian Timur	4	13.79
Institutional status of madrassas	Public	3	10.34
	Private	26	89.66
Accreditation rating	A	3	10.34
	B	12	41.38
	C	9	31.03
	Non Accredited	5	17.24

Source: Primary Data Analysis 2025

The research data were collected through document analysis, using secondary data from madrasah accreditation records. The data were obtained from assessments of 13 indicator statements outlined in the accreditation instrument, as specified in Appendix 1 of Ministerial Decree No. 209/P/2021, concerning the criteria and tools for accrediting primary and secondary education institutions. This accreditation instrument is key for evaluating school and madrasah management in educational unit assessments.

Data analysis was conducted using Principal Component Analysis (PCA), a multivariate statistical technique. PCA was chosen to reduce the complexity of multiple MI management variables into a smaller set of representative key components (Rahman et al., 2020; Salem & Hussein, 2019). Furthermore, Kurnaz (2020) The number of selected and accepted principal components must be smaller than the initial variables while retaining at least 80% to 90% of the total variance. All statistical analyses were conducted using R software, which is well-suited for processing multivariate data in alignment with this study's objectives.

RESULT

Validity of Research Data

This study aims to identify the dominant factors influencing the management of MI in Maluku Province using the Principal Component Analysis (PCA) approach. To ensure the validity of the analytical results, three key PCA assumptions must be met: (1) Sphericity (assessed using Bartlett's chi-square test), (2) Sample adequacy (evaluated using the Kaiser-Meyer-Olkin/KMO test), and (3) Determinant of the correlation matrix (variance–covariance). The results of these assumption tests are presented in Table 2.

Table 2. PCA Assumption Test

Parameter	Value	Interpretation
Sphericity test	p-value < 2.2e-16	Accepted
KMO	0.8567589	Accepted
Determinants	1.492917e-06	Accepted

Source: Primary Data Analysis 2025

Based on the data in Table 2, Bartlett's chi-square test confirms the presence of an identity matrix, yielding statistically significant results (p-value < 2.2e-16). This indicates that PCA is appropriate for this dataset. The KMO test produced a value of 0.86, close to 1, suggesting that the sample size (n = 29) is sufficient for PCA analysis. Additionally, the matrix determinant value of 1.492917e-06 indicates no multicollinearity issue among the variables.

The degree of compatibility between each variable and the others was further assessed using the Measure of Sampling Adequacy (MSA), where most values were found to be very good (MSA ≥ 0.80), as presented in Table 3. The findings in Table 3 demonstrate that each variable exhibits a high level of compatibility with other variables, reinforcing the suitability of PCA for this dataset.

Table 3. Sample Adequacy Based on MSA of Each Variable

Item Code	1	2	3	4	5	6	7	8	9	10	11	12	13
MSA	0.87	0.87	0.88	0.91	0.81	0.87	0.88	0.85	0.88	0.87	0.80	0.84	0.80

Source: Primary Data Analysis 2025

Based on these assumption tests, the primary PCA assumptions have been satisfied, allowing the analysis to determine the number of principal components that can explain the

variance within the data. The selection of principal components in PCA is based on eigenvalues and cumulative variance. The results of this analysis are presented in Table 4.

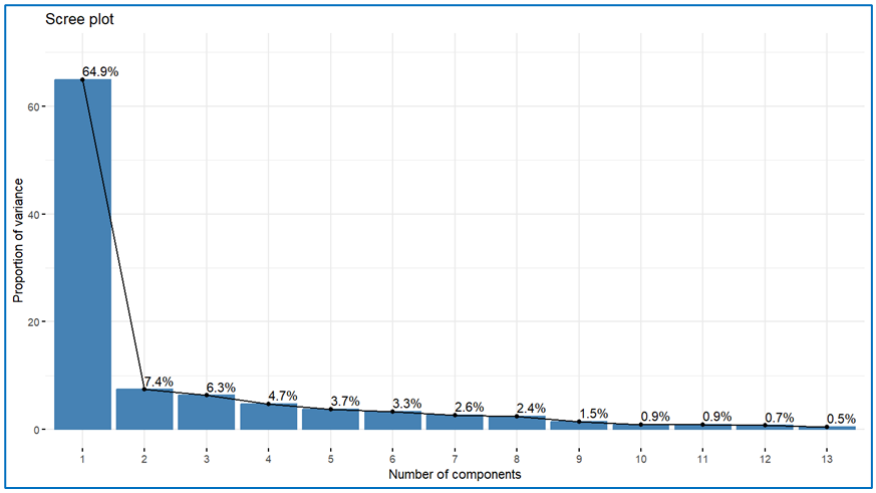
Table 4. Summary of the Number of Principal Components

Component	Eigenvalue	Proportion Variance	Cumulative Variance
1	8.439	0.649	0.649
2	0.965	0.074	0.723
3	0.823	0.063	0.787
4	0.610	0.047	0.834
5	0.484	0.037	0.871
6	0.430	0.033	0.904
7	0.343	0.026	0.930
8	0.318	0.024	0.955
9	0.190	0.015	0.969
10	0.121	0.009	0.979
11	0.119	0.009	0.988
12	0.097	0.007	0.995
13	0.061	0.005	1.000

Source: Primary Data Analysis 2025

Table 4 shows that the first principal component has an eigenvalue of 8.44 (eigenvalue > 1) with a cumulative variance of 64.9%. This indicates that the first component can explain 64.9% of the data variance, while the remaining 35.1% represents residual error. Since the cumulative variance has not yet reached 80%, the analysis continues up to the fourth component, which yields a cumulative variance of 83.4%. Accordingly, four principal components were selected as they collectively accounted for more than 80% of the total variance in the dataset. The scree plot illustrating the relationship between the number of principal components and the proportion of variance is presented in Figure 1.

Figure 1. Scree Plot Based on Eigenvalue



Source: Primary Data Analysis 2025

As shown in Figure 1, the elbow point is observed at the fourth component, with a total cumulative variance of 83.4%. This confirms that the dimensionality reduction process has effectively resulted in four principal components derived from the initial 13 factors. Furthermore,

these findings indicate that the PCA analysis successfully simplifies the data structure without causing significant information loss.

Calculation of the Coefficients of the Principal Components

The calculation of the coefficients of the principal components (PC1–PC4) is based on the eigenvector values of the correlation matrix between variables. This process is conducted in two steps: 1) applying factor rotation (varimax) to ensure each variable has a dominant loading factor in a specific component, and 2) analysing the correlation between variables to confirm that the principal component has a significant loading factor. The coefficient values of the principal components (PC1–PC4) are presented in Table 5.

Table 5. Principal Component Coefficients (PC1-PC4)

Kode Item	Initial Indicators/Factors	PC1	PC2	PC3	PC4
It1	Achievement of vision and mission	-0.287	-0.128	0.176	-0.075
It2	Competence of Madrasah Heads	-0.270	0.485	0.000	0.191
It3	Leadership of the madrasah heads	-0.296	-0.020	0.092	0.164
It4	Communication culture	-0.277	0.117	-0.418	-0.076
It5	Learning environment	-0.257	0.104	-0.618	-0.124
It6	Community involvement	-0.297	0.165	-0.071	0.331
It7	Curriculum management	-0.293	-0.332	0.069	-0.082
It8	Management of facilities and infrastructure	-0.286	-0.419	0.096	0.122
It9	Management of teachers and education personnel	-0.300	0.231	0.005	0.301
It10	Financing management	-0.286	-0.341	0.001	-0.096
It11	Student management	-0.216	0.416	0.600	-0.219
It12	Guidance on student achievement	-0.249	0.104	-0.017	-0.778
It13	Internal quality assurance	-0.280	-0.239	0.154	0.158

Source: Primary Data Analysis 2025

The analysis results indicate that each indicator has a coefficient value representing its contribution to each principal component (PC). The coefficient value may be positive or negative, but the absolute magnitude is of greater importance as it reflects the strength of the indicator's relationship with a particular principal component. For instance, the value of -0.287 on PC1 is the most significant absolute coefficient for It1 compared to other PCs. Similarly, a value of 0.485 on PC2 represents the highest absolute coefficient for It2, and so forth, with -0.280 on PC1 being the most significant absolute coefficient for It13. The magnitude of the absolute value suggests that an indicator contributes more significantly to explaining the variation within a specific component than in others. Furthermore, the component with the highest coefficient value for each indicator determines the names of the four principal components.

Based on the results presented in Table 5, four principal components were identified and named. A linear equation was then formulated to describe the relationship between the original variables and the derived principal components. The naming of these components and their corresponding linear equations (PC1–PC4) are as follows:

1. PC1 consists of indicators related to achieving the vision and mission (It1), the leadership of madrasah heads (It3), and internal quality assurance (It13). Therefore, PC1 is designated as Strategic Leadership and Madrasah Quality Assurance (SLMQA), with the following linear equation:

   SLMQA = -0.287It1 - 0.270It2 - 0.296It3 - 0.277It4 - 0.257It5 - 0.297It6 - 0.293It7 - 0.286It8 - 0.300It9 - 0.286It10 - 0.216It11 - 0.249It12 - 0.280It13

2. PC2 consists of indicators related to the competence of madrasah heads (It2), curriculum management (It7), management of facilities and infrastructure (It8), financial management (It10), and student affairs management (It11). Accordingly, PC2 is named Madrasah Resource Management (MRM), with the following linear equation:
   MRM = -0.128It1 + 0.485It2 - 0.020It3 + 0.117It4 + 0.104It5 + 0.165It6 - 0.332It7 - 0.419It8 + 0.231It9 - 0.341It10 + 0.416It11 + 0.104It12 - 0.239It13
3. PC3 consists of indicators related to communication culture (It4) and the learning environment (It5). Therefore, PC3 is designated as a Conducive Madrasah Environment (CME), with the following linear equation:
   CME = 0.176It1 + 0.000It2 + 0.092It3 - 0.418It4 - 0.618It5 - 0.071It6 + 0.069It7 + 0.096It8 + 0.005It9 + 0.001It10 + 0.600It11 - 0.017It12 + 0.154It13
4. PC4 consists of indicators related to community involvement (It6), management of teachers and education personnel (It9), and student achievement guidance (It12). Hence, PC4 is named Partnership Synergy with Madrasah Resources (PSMR), with the following linear equation:
   PSMR = -0.075It1 + 0.191It2 + 0.164It3 - 0.076It4 - 0.124It5 + 0.331It6 - 0.082It7 + 0.122It8 + 0.301It9 - 0.096It10 - 0.219It11 - 0.778It12 + 0.158It13

Determinants of MI Management

Based on the PCA method, the initial 13 indicators have been reduced to four principal components without significant information loss. These four principal components have been identified and named as follows: 1) Strategic Leadership and Madrasah Quality Assurance (SLMQA), 2) Madrasah Resource Management (MRM), 3) Conducive Madrasah Environment (CME), and 4) Partnership Synergy with Madrasah Resources (PSMR). These findings indicate that the key factors influencing the management of MI in Maluku Province extend beyond leadership and quality assurance. They also encompass resource management, creating a conducive environment, and the development of partnership synergy with all available resources within the madrasah. A summary of the overall research findings is presented in Table 6.

Table 6. Summary of Research Results

Focus of Analysis	Result	Interpretation
1. Validity of research data	The fulfilment of the three main assumptions of PCA. The Bartlett chi-square test is statistically significant (p-value < 2.2e-16), indicating that PCA is appropriate. a. The Kaiser-Meyer-Olkin (KMO) test yielded a value of 0.86, close to 1, suggesting that the sample size (n = 29) is adequate. b. The determinant value of the correlation matrix is 1.492917e-06, indicating no multicollinearity issues among the variables.	PCA can be further applied to determine the number of key components explaining the data's variability.
2. Calculation of the coefficients of the principal components	The coefficients of the principal components (PC1–PC4) were computed based on the eigenvector	Four principal components were identified and named based on the highest coefficient value in each component.

Focus of Analysis	Result	Interpretation
	values of the correlation matrix. This process involved two steps. a. Applying factor rotation (varimax). The results indicate that each variable has a dominant loading factor in a specific component. b. Analysing the correlation between variables. The results confirm that the principal components have significant loading factors.	
3. Determining factors for MI management	Four Principal Components of MI Management: Strategic Leadership and Madrasah Quality Assurance (SLMQA), a. Madrasah Resource Management (MRM), b. Conducive Madrasah Environment (CME), and Partnership Synergy with Madrasah Resources (PSMR).	The determining factors in managing MI in Maluku Province encompass leadership and quality assurance, resource management, a conducive environment, and partnership synergy with all available resources within the madrasah.

Source: Primary Data Analysis 2025

DISCUSSION

This study successfully identifies the determinant factors influencing the management of MI in Maluku Province through the Principal Component Analysis (PCA) approach. From the initial 13 indicators, four principal components make a significant contribution in explaining data variability, namely: Strategic Leadership and Madrasah Quality Assurance (SLMQA), Madrasah Resource Management (MRM), Conducive Madrasah Environment (CME), and Partnership Synergy with Madrasah Resources (PSMR). These four components collectively account for 83.4% of the total variance, indicating that the dimensional reduction process retains the essential information from the original dataset.

In greater detail, SLMQA (PC1) makes the most significant contribution to the effectiveness of madrasah management, accounting for 64.9% of the total variance. This finding confirms that the leadership of the madrasah head and the internal quality assurance system are the most dominant factors in ensuring effective madrasah management. These results reinforce the educational leadership theories proposed by Halliwell et al. (2023) and Sugiri (2022) This states that leadership effectiveness in educational institutions is directly correlated with improvements in education quality. However, this study provides a novel perspective by emphasising that leadership effectiveness is limited to strategic decision-making in the context of madrasahs. It encompasses a sustainable internal quality assurance system. (Javed & Alenezi, 2023; Litvaj et al., 2022).

There are notable differences between the findings of this study and those of previous research. A study by Widjaja et al. (2022) found that financial management contributes to the effectiveness of madrasah management. This study's results align with the findings of Warisno and Hidayah (2022), which indicate that madrasah leadership is a determining factor in madrasah

performance and creating a conducive learning environment. The present study, using PCA, reveals that leadership and quality management have a more significant contribution (64.9%), while financial factors are not identified as a primary determinant. This discrepancy suggests that the PCA approach employed in this study enables a more precise identification of dominant factors than conventional regression methods (Ngu et al., 2024; Wentzell et al., 2021).

Additionally, this study finds that MRM (PC2) plays a more significant role than previously reported. This component includes the competence of madrasah heads (It2), curriculum management (It7), facilities and infrastructure management (It8), financial management (It10), and student affairs management (It11). These findings provide a new perspective, highlighting that madrasahs with effective resource management are more stable in improving academic and non-academic quality. (Murni & Saputra, 2023; Noe et al., 2020; Rahmi et al., 2020). This insight complements previous studies, which have primarily focused on leadership aspects without considering resource management as a key factor in madrasah's effectiveness.

Furthermore, the study finds that CME (PC3) plays a crucial role in madrasah management, which has received limited attention in previous studies. The findings indicate a strong communication culture and positive interactions between teachers, students, and educational staff significantly correlate with madrasah governance improvements. (Kurniastuti et al., 2018). A positive learning environment and a strong communication culture in educational institutions directly enhance teacher motivation and student learning outcomes. (Hanaysha et al., 2023; Hawkins et al., 2023; Setiawan et al., 2024). Thus, these findings further highlight the importance of the madrasah environment in developing a more effective education system.

Moreover, this study reveals that PSMR (PC4) significantly contributes to madrasah management. Community involvement (It6), teacher and educational staff management (It9), and student achievement guidance (It12), along with other partnership synergies, have been proven to play a critical role in improving Madrasah governance. These findings support Deroncele-Acosta et al. (2023) Research demonstrates that community engagement and partnership synergy are essential factors for the sustainability of educational institutions.

About theoretical development, this study makes several significant contributions to the management of Islamic education. First, this study supports Halliwell et al. (2023) and Sugiri (2022) The theory of educational leadership reinforces that madrasah leadership plays a crucial role in management effectiveness. However, it also adds a new dimension, showing that effective madrasah leadership involves strategic decision-making and a sustainable internal quality assurance system. Second, this study critiques Widjaja et al. (2022) Findings emphasise financial factors as the primary determinant of madrasah effectiveness. In contrast, the present study demonstrates that strategic leadership and quality assurance contribute more significantly to educational quality improvement than financial factors. Third, this study expands the theory of Islamic education management by introducing partnership synergy as a key element in effective Madrasah governance. This study offers several novel contributions that can serve as a reference for future research. The contributions and novelty of the research results are presented in Table 7.

Table 7. Contribution and Novelty of the Research Results

Aspect	Previous Research	Contribution	Novelty
Analytical approach	First, Regression analysis examined the impact of	Introduces Principal Component Analysis	PCA has not been widely used in Islamic education

Aspect	Previous Research	Contribution	Novelty
	education management information systems on teacher professionalism and pedagogical competence (Lailia et al., 2021). The Exploratory Factor Analysis (EFA) was applied to identify factors influencing students' academic performance (Sumi et al., 2022).	(PCA) as a more accurate method to identify key factors in madrasah management compared to regression models or EFA.	management research, making this study one of the first to apply this approach to madrasah management.
Empirical approach	Achmad and Utami (2023) conducted a literature review on school partnership synergy for improving educational quality.	Provides empirical evidence that partnership synergy with madrasah resources significantly contributes to effective management.	It identifies partnership synergy as a new key determinant in Islamic education management, which was previously only discussed in theoretical studies.
Conceptual model for madrasah management	There are 13 factors used to measure school/madrasah management in the accreditation of educational institutions.	Develop a new conceptual model for madrasah management, integrating four main components: Strategic Leadership and Madrasah Quality Assurance, Madrasah Resource Management, Conducive Madrasah Environment, and Partnership Synergy with Madrasah Resources.	The proposed model serves as a framework for future policy development in madrasah management, offering a structured and holistic approach that has not been previously formulated.

Source: Primary Data Analysis 2025

Based on Table 7, several conclusions can be drawn. Firstly, the PCA approach in this study allows for a more precise identification of key factors in madrasah management compared to conventional regression methods. Previous studies, such as Lailia et al. (2021), employed regression analysis to assess the impact of education management information systems on teacher professionalism and pedagogical competence, while Sumi et al. (2022) utilized Exploratory Factor Analysis (EFA) to identify factors influencing secondary school students' academic performance. Secondly, this study highlights the significant contribution of partnership synergy with madrasah resources to the effectiveness of madrasah management, positioning partnership as a new determinant in Islamic education studies. These findings strengthen the arguments of Achmad and Utami (2023), whose research was limited to a literature review on school partnership synergy for quality education enhancement. Lastly, this study introduces a new conceptual model for madrasah management, consisting of four main components: KSPM, PSDM, LMK, and SKSDM. This

model provides a more effective framework for madrasah management policies while retaining the essential information from the previous 13 indicators.

The findings of this study suggest that, to enhance the effectiveness of madrasah management, madrasah leaders should strengthen the internal quality assurance system, optimise madrasah resource management, foster a conducive learning environment, and expand partnership synergies with the community and relevant stakeholders. Furthermore, these findings can serve as a foundation for data-driven madrasah management strategies, ensuring that decision-making processes are systematic and evidence-based.

CONCLUSION

The findings indicate that PCA is more accurate for identifying the key determinants of Madrasah Ibtidaiyah management in archipelagic regions than conventional regression models. Furthermore, PCA successfully identifies partnership synergy as a new determinant in Madrasah Ibtidaiyah management, previously only discussed in theoretical studies. Overall, PCA has identified four main components influencing Madrasah Ibtidaiyah management: Strategic Leadership and Madrasah Quality Assurance (SLMQA), Madrasah Resource Management (MRM), Conducive Madrasah Environment (CME), and Partnership Synergy with Madrasah Resources (PSMR). These four components collectively account for 83.4% of the total variance, with SLMQA emerging as the dominant factor (64.9%). These findings contribute to developing a new conceptual model for Madrasah Ibtidaiyah management, offering a structured and holistic framework that has not been formulated. This proposed model serves as a reference for future policy development aimed at enhancing the governance and effectiveness of Madrasah Ibtidaiyah in archipelagic regions.

This study has several limitations. Firstly, its scope is restricted to Madrasah Ibtidaiyah (MI) in archipelagic regions, meaning that the generalisability of the findings needs to be tested at other educational levels. Secondly, although the proposed conceptual model has been statistically validated, this study has not yet explored its practical implementation in education policy. Future research is recommended to extend the scope by examining the dominant factors influencing madrasah management at the Tsanawiyah (MTs), Aliyah (MA), and higher education levels, thereby providing a more comprehensive understanding of Islamic education governance in Indonesia. Additionally, subsequent studies could assess the effectiveness of this model within broader educational policies, particularly in terms of how policy interventions can strengthen madrasah strategic leadership and quality assurance systems.

REFERENCES

Achmad, W. K. S., & Utami, U. (2023). The Synergy of the School Partnership Model in the Success of Educational Transformation. *Unima International Conference on Social Sciences and Humanities (UNICSSH 2022)*, 1247–1253. https://doi.org/10.2991/978-2-494069-35-0_150

Bahar, R., Silvianti, P., & Susetyo, B. (2021). Penggerombolan Mutu SMA/MA per Provinsi Berdasarkan Hasil Akreditasi Menggunakan Metode Fuzzy C-Means. *Xplore: Journal of Statistics*, *10*(3), 271–288. https://doi.org/10.29244/xplore.v10i3.842

BAN S/M Provinsi Maluku. (2021). *Laporan Akhir Pelaksanaan Program Akreditasi Sekolah/Madrasah Provinsi Maluku Tahun 2021*. LPMP Maluku.

Deroncele-Acosta, A., Jiménez-Chumacero, R. V., Gamarra-Mendoza, S., Brito-Garcías, J. G., Flores-Valdivieso, H. G., Velázquez-Tejeda, M. E., & Goñi-Cruz, F. F. (2023). Trends in Educational Research for Sustainable Development in Postgraduate Education Programs at a University in Peru. *Sustainability*, *15*(6), 5449. https://doi.org/10.3390/su15065449

Donkoh, R., Lee, W. O., Ahoto, A. T., Donkor, J., Twerefoo, P. O., Akotey, M. K., & Ntim, S. Y. (2023). Effects of educational management on quality education in Ghana's rural and urban primary schools. *Heliyon*, *9*(11). https://doi.org/10.1016/j.heliyon.2023.e21325

El Widdah, M. (2022). Madrasah Management Strategy as the Education Base for Religious Cadre. *International Journal of Learning, Teaching and Educational Research*, *21*(11), 227–242. https://doi.org/10.26803/ijlter.21.11.13

Halliwell, P. R., Mitchell, R. J., & Boyle, B. (2023). Leadership effectiveness through coaching: authentic and change-oriented leadership. *Plos One*, *18*(12), e0294953. https://doi.org/10.1371/journal.pone.0294953

Hanaysha, J. R., Shriedeh, F. B., & In'airat, M. (2023). Impact of classroom environment, teacher competency, information and communication technology resources, and university facilities on student engagement and academic performance. *International Journal of Information Management Data Insights*, *3*(2), 100188. https://doi.org/10.1016/j.jjimei.2023.100188

Hawkins, G. T., Chung, C. S., Hertz, M. F., & Antolin, N. (2023). The school environment and physical and social-emotional well-being: implications for students and school employees. *Journal of School Health*, *93*(9), 799–812. https://doi.org/10.1111/josh.13375

Huda, K. (2016). Problematika madrasah dalam meningkatkan mutu pendidikan islam. *Dinamika Penelitian: Media Komunikasi Penelitian Sosial Keagamaan*, *16*(2), 309–336. https://doi.org/10.21274/dinamika.2016.16.2.309-336

Isaac, S., & Michael, W. B. (1971). *Handbook in research and evaluation*. Edit publishers.

Javed, Y., & Alenezi, M. (2023). A case study on sustainable quality assurance in higher education. *Sustainability*, *15*(10), 8136. https://doi.org/10.3390/su15108136

Juhaeni, A., Sanusi, A., Wasliman, I., & Hanafiah, H. (2021). Strategic management of quality improvement of madrasah aliyah graduates in modern islamic boarding schools. *Tarbawi: Jurnal Keilmuan Manajemen Pendidikan*, *7*(01), 33–46. https://doi.org/10.32678/tarbawi.v7i01.4179

Kabwos, C. R., Moige, N. O., & Omwenga, E. N. (2020). Availability and adequacy of learning resources for implementing inclusive education in Belgut Sub-County, Kenya public preschools. *European Journal of Education Studies*. https://doi.org/10.5281/zenodo.3665750

Kurnaz, F. S. (2020). Some Regression Methods Based on Principal Components. *Gümüshane Üniversitesi Fen Bilimleri Enstitüsü Dergisi*, *10*(3). https://doi.org/10.17714/gumusfenbil.641791

Kurniastuti, I., Setyawan, T. Y., & Sonialopita, S. (2018). Designing essential questions in teaching and learning to deepen understanding and develop students' awareness of the environment. *Jurnal Cakrawala Pendidikan*, *37*(1). https://doi.org/10.21831/cp.v37i1.15125

Lailia, D. R., Fahyuni, E. F., & Arifin, M. B. U. B. (2021). Management Educational Information System During Pandemic COVID-19 Through Teachers' Professionalism and Pedagogic. *Nidhomul Haq: Jurnal Manajemen Pendidikan Islam*, *6*(1), 144–162. https://doi.org/10.31538/ndh.v6i1.1341

Litvaj, I., Ponisciakova, O., Stancekova, D., Svobodova, J., & Mrazik, J. (2022). Decision-making procedures and their relation to knowledge management and quality management.

Sustainability, *14*(1), 572. https://doi.org/10.3390/su14010572

Liu, J., Kang, H., Tao, W., Li, H., He, D., Ma, L., Tang, H., Wu, S., Yang, K., & Li, X. (2023). A spatial distribution–Principal component analysis (SD-PCA) model to assess pollution of heavy metals in soil. *Science of The Total Environment*, *859*, 160112. https://doi.org/10.1016/j.scitotenv.2022.160112

Maesaroh, S. (2018). Manajemen Peningkatan Kompetensi Lulusan Di Madrasah. *Jurnal Isema: Islamic Educational Management*, *3*(1). https://doi.org/10.15575/isema.v3i1.3280

Moeis, F. R. (2022). Unraveling the myth of madrasah formal education quality in Indonesia: a labor quality approach. *Educational Research for Policy and Practice*, *21*(2), 177–200. https://doi.org/10.1007/s10671-021-09298-6

Murni, M., & Saputra, N. (2023). Increasing Academic Achievement through Madrasah Principal Strategies. *Nidhomul Haq: Jurnal Manajemen Pendidikan Islam*, *8*(3), 386–400. https://doi.org/10.31538/ndh.v8i3.4124

Ngu, J. C. Y., Yeo, W. S., Thien, T. F., & Nandong, J. (2024). A comprehensive overview of the applications of kernel functions and data-driven models in regression and classification tasks in the context of software sensors. *Applied Soft Computing*, 111975. https://doi.org/10.1016/j.asoc.2024.111975

Noe, R. A., Hollenbeck, J. R., Gerhart, B., & Wright, P. M. (2020). *Fundamentals of human resource management*. McGraw-Hill.

Nuraeni, R., Manggala, T. S., Mutmainah, N. A., & Wulandari, R. T. (2022). The influence of madrasah organizational characteristics on the principal decision-making. *AL-TANZIM: Jurnal Manajemen Pendidikan Islam*, *6*(2), 327–337. https://doi.org/10.33650/al-tanzim.v6i2.3244

Nurhayati, R., Suranto, S., Dwiningrum, S. I. A., Efianingrum, A., Herwin, H., & Haryanto, H. (2022). Principal component analysis on bullying measurement models in schools. *Sciences*, *17*(8), 2771–2781. https://doi.org/https://doi.org/10.18844/cjes.v17i8.7803

Ongere, R. N., & Ogochi, G. (2023). Assessment of the School Resources Availability in Public Day Secondary Schools in Kenya: Case of Manga Sub-County. *East African Journal of Education Studies*, *6*(3), 287–296. https://doi.org/10.37284/eajes.6.3.1561

Pambudi, N. A., & Harjanto, B. (2020). Vocational education in Indonesia: History, development, opportunities, and challenges. *Children and Youth Services Review*, *115*, 105092. https://doi.org/10.1016/j.childyouth.2020.105092

Rahman, M. A., Hossain, M. F., Hossain, M., & Ahmmed, R. (2020). Employing PCA and t-statistical approach for feature extraction and emotion classification from multichannel EEG signal. *Egyptian Informatics Journal*, *21*(1), 23–35. https://doi.org/10.1016/j.eij.2019.10.002

Rahmi, E., Patoni, A., & Sulistyorini, S. (2020). The Management of Human Resources Development in Increasing the Quality of Islamic Education Institutions. *Al-Ta Lim Journal*, *27*(2), 166–178. https://doi.org/10.15548/jt.v27i2.624

Rakhmani, I., & Sakhiyya, Z. (2024). Inequalities and social sciences in neoliberal Indonesia. *International Social Science Journal*, *74*(251), 9–23. https://doi.org/10.1111/issj.12429

Rawal, D. M. (2024). Mapping of school teachers' digital competency in the context of digital infrastructure: a systematic review and empirical study of India. *Journal of Professional Capital and Community*. https://doi.org/10.1108/JPCC-01-2024-0016

Salem, N., & Hussein, S. (2019). Data dimensional reduction and principal components analysis.

Procedia Computer Science, *163*, 292–299. https://doi.org/10.1016/j.procs.2019.12.111

Setiawan, R., Hadi, S., & Aman, A. (2024). Psychometric properties of learning environment diagnostics instrument. *Journal of Education and Learning (EduLearn)*, *18*(3), 690–698. https://doi.org/10.11591/edulearn.v18i3.21310

Skinner, B., Leavey, G., & Rothi, D. (2021). Managerialism and teacher professional identity: Impact on well-being among teachers in the UK. *Educational Review*, *73*(1), 1–16. https://doi.org/10.1080/00131911.2018.1556205

Sugiri, U. (2022). The leadership of the Head of Madrasah in Improving the Quality of Education. *Nidhomul Haq: Jurnal Manajemen Pendidikan Islam*, *7*(2), 295–306. https://doi.org/10.31538/ndh.v7i2.2184

Sumi, S. S., Mondal, B. K., Jahan, N., Seddeque, A., & Hossain, M. T. (2022). Determinants of academic achievement at secondary levels: a study in Magura district of Bangladesh. *MOJEM: Malaysian Online Journal of Educational Management*, *10*(1), 21–44.

Symaco, L. P., & Bustos, M. T. A. P. (2022). Overview of Education in the Philippines. In *International Handbook on Education in South East Asia* (pp. 1–27). Springer. https://doi.org/10.1007/978-981-16-8136-3_1-2

Tambrin, M., Wasliman, I., Hanafiah, H., & Mudrikah, A. (2021). Implement and evaluate teachers' performance supervision at Madrasah Aliyah (Islamic Senior High School). *Journal of Education Research and Evaluation*, *5*(4), 645–655. https://doi.org/10.23887/jere.v5i4.32941

Ünel, F. B., & Yalpir, S. (2019). Reduction of mass appraisal criteria with principal component analysis and integration to GIS. *International Journal of Engineering and Geosciences*, *4*(3), 94–105. https://doi.org/10.26833/ijeg.458430

Wakano, A., Latuapo, R., Lapele, F., & Prihono, E. W. (2024). Measuring Teacher Personality Competence: Era 5.0 Challenges for Teachers in Indonesian Archipelago. *AL-ISHLAH: Jurnal Pendidikan*, *16*(3), 4047–4057. https://doi.org/10.35445/alishlah.v16i3.4713

Warisno, A., & Hidayah, N. (2022). Investigating principals' leadership to develop teachers' professionalism at madrasah. *AL-TANZIM: Jurnal Manajemen Pendidikan Islam*, *6*(1), 603–616. https://doi.org/10.33650/al-tanzim.v6i2.3570

Wentzell, P. D., Giglio, C., & Kompany-Zareh, M. (2021). Beyond principal components: A critical comparison of factor analysis methods for subspace modelling in chemistry. *Analytical Methods*, *13*(37), 4188–4219. https://doi.org/10.1039/D1AY01124C

Widjaja, G., Supriani, Y., bin Zainal Badri, K. N., Bangkara, B. A., & Zuhri, M. I. I. (2022). Improving The Quality of Madrasas Through Financial Management. *Nidhomul Haq: Jurnal Manajemen Pendidikan Islam*, *7*(3), 330–343. https://doi.org/10.31538/ndh.v7i3.2606

Yu, Y., Appiah, D., Zulu, B., & Adu-Poku, K. A. (2024). Integrating Rural Development, Education, and Management: Challenges and Strategies. *Sustainability*, *16*(15), 6474. https://doi.org/10.3390/su16156474