A Data-Driven IT Governance Framework for Improving Digital Education Services in Islamic Madrasahs

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Abstract.

This study proposes a data-driven IT governance framework to improve the quality of digital education services in Islamic madrasahs under Indonesia's Ministry of Religious Affairs. The framework integrates COBIT 2019 and Big Data Analytics to evaluate IT governance capabilities, analyze digital service performance, and support evidence-based decision-making. COBIT 2019 provides a structured approach to assessing governance and management processes, while Big Data Analytics enables the identification of service patterns, performance gaps, and opportunities for improvement using educational data. The research adopts a quantitative approach supported by descriptive analysis, stakeholder assessments, and analytical evaluation of digital service indicators. The proposed framework focuses on governance effectiveness, information quality, system reliability, service accessibility, and user satisfaction. The expected contribution is an integrated evaluation model that connects IT governance maturity with data-driven service optimization. This framework is expected to strengthen institutional accountability, operational efficiency, and the sustainability of digital education services in Islamic madrasahs.

Keywords: IT Governance, COBIT 2019, Big Data Analytics, Digital Education Services, Islamic Madrasahs.

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Introduction.

The rapid development of information technology has accelerated digital transformation in the education sector, including the delivery of educational services in Islamic madrasahs. Digital transformation is no longer limited to the implementation of information systems but also involves the integration of digital infrastructure, data management, information security, and institutional decision-making. Educational institutions are increasingly required to provide reliable, accessible, transparent, and responsive digital services to meet the needs of students, teachers, parents, and education administrators. In this context, effective IT governance is essential to ensure that technology investments generate measurable organizational benefits and support sustainable improvements in educational service quality.

Digital transformation in education has become an important agenda for improving institutional effectiveness, expanding access to educational services, and strengthening evidence-based decision-making. However, the successful implementation of educational technology depends not only on the availability of digital platforms but also on governance arrangements, infrastructure readiness, data quality, and institutional capacity. UNESCO (2023) emphasizes that technology can contribute to educational access, inclusion, quality, and system management when supported by appropriate governance, regulation, and teacher preparation. Therefore, digital transformation requires an integrated approach that connects technology implementation with institutional objectives and measurable service outcomes.

In Indonesia, the Ministry of Religious Affairs has undertaken digital transformation initiatives to strengthen the management of religious education data and services. One important initiative is the implementation of the Education Management Information System (EMIS), which supports the management of educational information within the Ministry's institutional environment. Furthermore, the Ministry introduced the Digital Madrasah Performance Report (Rapor Kinerja Madrasah), integrating several educational data platforms, including EMIS, AKMI, AKG, EDM, and e-RKAM. This integration demonstrates the increasing importance of data interoperability and consolidated information in evaluating madrasah performance and supporting institutional decision-making (Kementerian Agama Republik Indonesia, 2024). Despite these developments, the availability of multiple digital platforms does not automatically guarantee optimal educational service quality. Potential challenges include fragmented data management, inconsistent information, limited system integration, inadequate information security, and differences in institutional technology capabilities. These conditions may affect the accuracy of educational information, the efficiency of administrative processes, and the responsiveness of digital services. Consequently, madrasah digital transformation requires an effective IT governance mechanism to ensure that technology resources are managed consistently, risks are controlled, and digital services remain aligned with institutional objectives.

IT governance provides a structured mechanism for directing, monitoring, and evaluating the use of information technology within an organization. COBIT 2019 offers a comprehensive framework for aligning IT governance and management objectives with organizational strategies, stakeholder needs, and institutional priorities. Previous studies have demonstrated the relevance of COBIT 2019 in educational institutions. Utomo et al. (2022) showed how COBIT 2019 design factors can be used to identify governance and management priorities in higher education institutions. Similarly, Wattimury and Faza (2023) applied COBIT 2019 to evaluate IT governance in an educational institution and identified capability gaps requiring improvement. These studies indicate that COBIT 2019 can support systematic governance assessment and the formulation of institutional improvement strategies.

In addition to governance, the increasing volume and diversity of educational data create opportunities to improve institutional performance through Big Data Analytics. Educational institutions generate data from student administration, academic activities, institutional assessments, digital platforms, and educational management systems. When processed

systematically, these data can provide insights into service performance, institutional needs, operational efficiency, and potential areas for improvement. Stojanov and Daniel (2024), through a systematic review of Big Data and analytics research, identified the potential of data analytics to support learning, teaching, and administrative decision-making. Their findings highlight that the value of educational data extends beyond learning activities to include institutional management and organizational decision-making. The integration of COBIT 2019 and Big Data Analytics therefore offers an opportunity to establish a more comprehensive approach to digital education service management. COBIT 2019 can provide the governance structure for managing IT resources, assessing process capabilities, and controlling technology-related risks. Meanwhile, Big Data Analytics can support the analysis of educational service data to identify performance patterns, information gaps, and improvement priorities. The combination of these approaches is expected to connect governance evaluation with measurable, data-driven institutional improvements.

However, existing studies have generally examined IT governance assessment and educational data analytics as separate research areas. Studies applying COBIT 2019 have primarily focused on governance capability and process improvement, while Big Data Analytics research has emphasized learning analytics and data-driven decision-making. There remains an opportunity to integrate these approaches into a framework specifically designed to evaluate and improve digital education services in Islamic madrasahs under the Ministry of Religious Affairs. Such integration is important because madrasah services involve multiple stakeholders, interconnected information systems, and diverse administrative and educational processes. Based on this research gap, this study proposes A Data-Driven IT Governance Framework for Improving Digital Education Services in Islamic Madrasahs. The study aims to integrate COBIT 2019 and Big Data Analytics into an evaluation framework that connects IT governance capability, educational data management, digital service performance, and institutional improvement priorities. Specifically, the research seeks to: (1) assess IT governance capabilities using relevant COBIT 2019 objectives; (2) analyze educational service data to identify performance patterns and service improvement opportunities; and (3) formulate a data-driven governance framework to support the optimization of digital education services. The proposed framework is expected to contribute to more accountable, integrated, and sustainable digital governance in Islamic madrasahs.

Literature Review.

2.1. IT Governance in Digital Education

IT governance is an organizational mechanism for ensuring that information technology resources support institutional objectives, deliver value, and manage technology-related risks. In educational institutions, IT governance covers strategic alignment, digital infrastructure management, information security, system performance, and the sustainability of digital services. Digital education transformation requires institutions to move beyond technology adoption toward integrated management of information, processes, and organizational capabilities. UNESCO (2023) emphasizes that educational technology should be evaluated based on its contribution to accessibility, equity, quality, and institutional effectiveness rather than simply the availability of digital tools.

In this context, IT governance in Islamic madrasahs is particularly important because educational services involve various stakeholders, including the Ministry of Religious Affairs, madrasah administrators, teachers, students, and parents. Effective governance can help ensure that digital platforms operate consistently, educational information is managed appropriately, and technology investments contribute to institutional performance.

2.2. COBIT 2019 Framework

COBIT 2019 is an IT governance and management framework designed to align technology capabilities with organizational objectives. Its governance system consists of principles, components, processes, and design factors that allow organizations to establish governance arrangements according to their specific requirements.

The framework consists of five governance and management domains:
1. Evaluate, Direct, and Monitor (EDM): Evaluates stakeholder needs, provides strategic direction, and monitors governance performance.
2. Align, Plan, and Organize (APO): Addresses IT strategy, enterprise architecture, risk management, security, and data management.
3. Build, Acquire, and Implement (BAI): Manages the development, acquisition, and implementation of IT solutions.
4. Deliver, Service, and Support (DSS): Focuses on operational services, incident management, continuity, and security.
5. Monitor, Evaluate, and Assess (MEA): Evaluates IT performance, internal controls, and compliance.

COBIT 2019 is relevant to educational institutions because it provides a structured mechanism for identifying governance weaknesses and determining improvement priorities. Its design factor approach also allows governance objectives to be selected based on institutional strategies, risk profiles, and operational requirements (ISACA, 2023). Recent literature reviews indicate that COBIT-based assessments remain relevant for evaluating IT governance in educational organizations. Rosanti et al. (2024), for example, examined IT governance implementation in the education sector and highlighted the importance of structured governance evaluation.

2.3. Big Data Analytics in Educational Institutions

Big Data Analytics refers to the process of collecting, integrating, processing, and analyzing large and diverse datasets to generate meaningful information for decision-making. In educational institutions, data may originate from student information systems, academic records, learning management systems, institutional assessments, teacher administration, and digital service platforms. Stojanov and Daniel (2024) reviewed 75 studies on Big Data and analytics in higher education. Their findings indicate that analytics is used to support learning, teaching, and administrative decision-making, although administrative applications remain less developed than learning-related applications. This finding suggests that educational data analytics has opportunities beyond classroom activities, particularly in institutional planning and service management. Similarly, Lin et al. (2024) analyzed 44 empirical studies on Big Data-driven educational evaluation. Their review identified applications in learning performance prediction, learning behavior analysis, teaching management decision-making, and educational evaluation optimization. These findings demonstrate the potential of analytics to transform educational data into actionable information for institutional improvement.
For Islamic madrasahs, Big Data Analytics can be applied to several operational areas:
- Student data analytics: Analyzing enrollment, attendance, academic progress, and student development.
- Teacher and personnel analytics: Evaluating teacher distribution, professional development, and administrative performance.
- Institutional performance analytics: Identifying patterns in accreditation, assessment, and madrasah performance indicators.
- Digital service analytics: Monitoring system usage, service accessibility, response time, and user feedback.
- Decision-support analytics: Providing evidence to support resource allocation, institutional planning, and service improvement.

The application of Big Data Analytics requires more than advanced analytical algorithms. It also depends on data quality, interoperability, data security, analytical competencies, and clear institutional responsibilities. Therefore, analytics should operate within an appropriate IT governance structure.

2.4. Digital Education Service Quality

Digital education service quality refers to the ability of digital platforms and information systems to provide accessible, reliable, accurate, secure, and responsive services to educational stakeholders. In Islamic madrasahs, digital services include student administration, educational data management, institutional reporting, teacher services, and educational performance monitoring. Service quality can be evaluated through several dimensions:

1. System reliability: The ability of digital platforms to operate consistently with minimal interruption.
2. Information quality: The accuracy, completeness, relevance, and timeliness of educational information.
3. Accessibility: The ease with which authorized users access digital services.
4. Responsiveness: The ability of the institution to respond to user requests, complaints, and technical problems.
5. Information security: The protection of educational data against unauthorized access, alteration, or disclosure.
6. User satisfaction: The extent to which digital services meet stakeholder expectations and operational needs.

UNESCO (2023) highlights that technology in education should be assessed according to its contribution to educational objectives, inclusion, and quality. This perspective reinforces the importance of evaluating digital education services based on their actual institutional and user benefits rather than merely measuring technology availability. Alonzo et al. (2024) also identified the importance of data-system characteristics, institutional leadership, individual readiness, and sociocultural conditions in supporting data-driven decision-making in schools. These factors indicate that service quality is influenced by both technological and organizational capabilities.

2.5. Integration of COBIT 2019 and Big Data Analytics

The integration of COBIT 2019 and Big Data Analytics provides a complementary approach to improving digital education services. COBIT 2019 establishes the governance structure, responsibilities, control mechanisms, and performance evaluation processes. Big Data Analytics provides the analytical capability to process educational data and identify opportunities for operational improvement. The proposed integration consists of four interconnected dimensions:

- Governance assessment: Evaluating IT governance capabilities, strategic alignment, risk management, and institutional accountability using COBIT 2019.
- Data integration and management: Assessing the availability, consistency, completeness, security, and interoperability of educational data.
- Analytical performance evaluation: Using descriptive and diagnostic analytics to identify service performance patterns and operational gaps.
- Continuous improvement: Translating governance assessment and analytical findings into measurable improvement recommendations.

Recent research on COBIT 2019 implementation identifies strategic alignment, risk management, resource optimization, and operational efficiency as important benefits. It also highlights implementation challenges involving limited resources, framework complexity, and

stakeholder understanding (Antariksa et al., 2025). In educational institutions, Tulus and Tanaamah (2023) examined the design of IT governance using COBIT 2019, demonstrating the relevance of the framework for structuring institutional IT governance. These findings support the use of COBIT 2019 as the governance foundation for a data-driven education service model.

2.6. Research Gap and Proposed Framework

Based on the reviewed literature, three important research gaps can be identified.

First, previous COBIT 2019 studies have primarily concentrated on evaluating IT governance capabilities, identifying process weaknesses, and formulating improvement recommendations. Tulus and Tanaamah (2023) demonstrate the application of COBIT 2019 in educational institutions, particularly in assessing governance processes and identifying areas requiring improvement. However, governance assessment needs to be connected more directly with measurable digital education service performance.

Second, Big Data Analytics research has demonstrated its potential to support educational evaluation, learning analysis, and institutional decision-making (Lin et al., 2024; Stojanov & Daniel, 2024). Nevertheless, the application of analytics should be supported by appropriate data governance, information security, and institutional accountability mechanisms.

Third, educational data-driven decision-making is influenced not only by technology but also by leadership, data-system characteristics, user readiness, and organizational conditions (Alonzo et al., 2024). This indicates the need for an integrated framework that combines IT governance capability, data management, analytical performance, and digital service quality.

Table 1. Address these gaps, this study proposes an integrated framework consisting of four main components.

Component	Main focus	Expected outcome
COBIT 2019 governance	Governance capability, risk, security, and monitoring	Governance improvement priorities
Educational data management	Data quality, integration, interoperability, and security	Reliable educational data
Big Data Analytics	Descriptive and diagnostic analysis	Service performance insights
Digital service evaluation	Reliability, accessibility, responsiveness, and satisfaction	Improved digital education services

The proposed framework positions IT governance as the institutional foundation, educational data management as the information infrastructure, and Big Data Analytics as the analytical mechanism for identifying service improvement opportunities.

2.7. Conceptual Relationship of the Research

The conceptual framework establishes the relationship between IT governance, educational data management, Big Data Analytics, and digital education service quality.

The proposed relationships are:

- H1: IT governance capability positively influences educational data management effectiveness.
- H2: Educational data management effectiveness positively influences Big Data Analytics capability.
- H3: Big Data Analytics capability positively influences digital education service quality.
- H4: IT governance capability positively influences digital education service quality.
- H5: Big Data Analytics mediates the relationship between educational data management and digital education service quality.

These hypotheses provide a basis for empirical evaluation. Their validity must be tested using actual institutional data and appropriate statistical methods.

Research Methodology.

This study adopts a quantitative research approach with a descriptive and explanatory design to develop a data-driven IT governance framework for improving digital education services in Islamic madrasahs under Indonesia's Ministry of Religious Affairs. The research integrates the COBIT 2019 framework and Big Data Analytics to evaluate IT governance capabilities, examine educational data management, and assess digital service performance. The research is conducted through four main stages:
(1) IT governance assessment using COBIT 2019;
(2) educational data management evaluation;
(3) Big Data Analytics for identifying service performance patterns; and
(4) formulation of an integrated governance framework.
The research focuses on connecting institutional governance capabilities with measurable improvements in digital education services. The research focuses on Islamic madrasahs operating under the Ministry of Religious Affairs in Indonesia. The study involves relevant stakeholders responsible for educational information systems, digital services, and institutional data management.
The research uses two categories of data:
Primary data:
- Questionnaires distributed to madrasah administrators and educational information system operators.
- Interviews with IT managers, education administrators, and relevant stakeholders.
- Expert assessments of IT governance priorities and digital service performance.

Secondary data:
- Educational data from the Education Management Information System (EMIS).
- Madrasah institutional performance data.
- Digital service usage and administrative records.
- Relevant institutional policies, reports, and system documentation.

The selection of datasets depends on data availability, institutional authorization, data completeness, and applicable personal data protection requirements.

Table 2. The study identifies four main research constructs.

Variable	Indicators	Measurement
IT Governance (X1)	Strategic alignment, risk management, security, performance monitoring	COBIT 2019 assessment
Data Management (X2)	Data quality, completeness, consistency, integration, security	Data quality assessment
Big Data Analytics (X3)	Data processing, descriptive analytics, diagnostic analytics, analytical insights	Analytics performance
Digital Service Quality (Y)	Reliability, accessibility, responsiveness, information quality, user satisfaction	Likert scale

The questionnaire uses a five-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). COBIT governance capability is assessed separately using the COBIT 2019 capability assessment approach. COBIT 2019 is used to evaluate governance and management capabilities relevant to digital education services. The selection of governance objectives considers institutional priorities, technology risks, data management requirements, and service delivery needs.

Table 3. The initial governance objectives

Domain	COBIT Objective	Assessment Focus	Domain
APO	APO12	Managed Risk	APO

APO	APO13	Managed Security	APO
APO	APO14	Managed Data	APO
DSS	DSS01	Managed Operations	DSS
DSS	DSS02	Managed Service Requests and Incidents	DSS
MEA	MEA01	Managed Performance and Conformance Monitoring	MEA

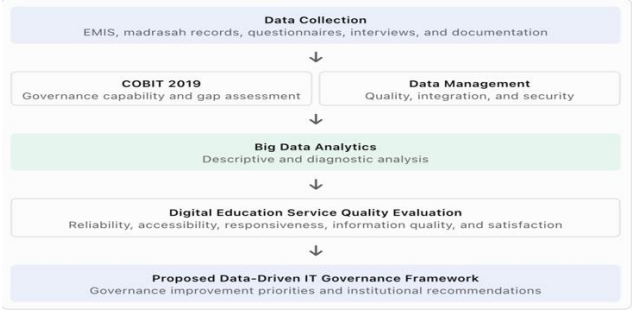


Figure 1. Research Framework

Questionnaire instruments are evaluated through expert judgment and pilot testing before full data collection. Reliability is assessed using Cronbach's Alpha and Composite Reliability, while validity is examined through convergent and discriminant validity. Data collection and analysis must comply with institutional authorization and applicable personal data protection regulations. Student and teacher identities must be protected through anonymization or pseudonymization. Only authorized and relevant educational data are processed, and access to sensitive institutional records is restricted.

RESULTS.

4.1. IT Governance Assessment Based on COBIT 2019

The IT governance assessment focuses on identifying the capability of governance and management processes supporting digital education services in Islamic madrasahs.The select ed COBIT 2019 objectives include APO12, APO13, APO14, DSS01, DSS02, and MEA01.

Table 4. COBIT 2019 Governance Assessment

COBIT Objective	Assessment Focus	Actual Level	Target Level
APO12	IT Risk Management	To be assessed	3
APO13	Information Security	To be assessed	3
APO14	Data Management	To be assessed	4
DSS01	Operational Management	To be assessed	3
DSS02	Service Requests and Incidents	To be assessed	3
MEA01	Performance Monitoring	To be assessed	4

The target levels in Table 4 are preliminary planning assumptions, not established findings. Fi nal targets must be determined through COBIT 2019 design factors and stakeholder requirem ents. The capability gap is calculated using:

$$Gi = CL^{Target,i} - CL^{Actual,i} \quad (1)$$

A positive gap indicates that the assessed governance process has not reached its target capabi lity. The results can be used to identify which governance processes require immediate impro vement.

4.2. Educational Data Management Analysis

Educational data management is an important component of digital madrasah services because institutional decisions depend on accurate, complete, consistent, and timely in formation. The evaluation examines five data quality dimensions.

Table 5. Educational Data Quality Indicators

Data Quality Dimension	Evaluation Criteria	Expected Analytical Output
Accuracy	Correctness of educational records	Data accuracy percentage
Completeness	Availability of required data fields	Completeness percentage
Consistency	Uniformity across institutional records	Data consistency rate
Timeliness	Availability of updated information	Data update frequency
Integration	Compatibility between educational systems	Integration performance

The data quality score can be calculated using:

$$DQ = \frac{\sum_{i=1}^{n} S_i}{n} \quad (2)$$

Where:

- DQ = Average data quality score.
- S_i = Individual indicator score.
- n = Number of assessed indicators.

The analysis is expected to identify data management weaknesses, including incomplete recor ds, duplicate information, inconsistent formats, and delays in updating institutional data. These findings can provide a foundation for improving data governance and supporting more reliable educational services.

Table 3. Big Data Analytics Applications

Analytical Method	Data Source	Analytical Objective
Descriptive Analytics	Student and institutional records	Identify educational data distributions
Trend Analysis	Historical madrasah records	Examine changes in institutional performance
Comparative Analysis	Madrasah performance indicators	Compare service performance across institutions
Diagnostic Analytics	Service and administrative records	Identify factors associated with service problems
Data Visualization	Integrated educational datasets	Present institutional performance dashboards

The results of these analyses are expected to support:

1. Identification of educational service performance patterns.

2. Detection of incomplete or inconsistent institutional data.
3. Monitoring of digital service utilization.
4. Identification of differences in service performance across madrasahs.
5. Evidence-based prioritization of institutional improvement.

The use of historical data is particularly important because it allows institutional performance to be examined across different observation periods rather than relying exclusively on a single reporting cycle.

4.3. Digital Education Service Quality Analysis

Digital education service quality is evaluated through five dimensions: system reliabili ty, information quality, accessibility, responsiveness, and user satisfaction.

Table 4. Digital Education Service Quality Indicators

Dimension	Measurement Indicator	Expected Evaluation
System Reliability	System availability and operational stability	Technical service performance
Information Quality	Accuracy and completeness of information	Information reliability
Accessibility	Ease of accessing digital services	User access performance
Responsiveness	Speed of responding to user requests	Service responsiveness
User Satisfaction	User perceptions of service performance	Overall service satisfaction

The proposed framework highlights the importance of integrating IT governance and educatio nal data analytics in the digital transformation of Islamic madrasahs.
First, COBIT 2019 provides a structured governance mechanism for managing technology ris ks, information security, data resources, and digital service operations. The assessment of gov ernance capabilities can help institutions identify operational weaknesses and establish measu rable improvement targets.
Second, educational data management determines the reliability of analytical outputs. Inaccur ate, incomplete, or inconsistent data may produce misleading analytical results. Therefore, dat a quality and interoperability must be established before advanced analytics are implemented.
Third, Big Data Analytics provides opportunities to transform educational records into inform ation that supports institutional monitoring and decisionmaking. Descriptive and diagnostic an alytics can help identify service performance patterns and potential administrative problems.
Finally, digital education service quality represents the organizational outcome of effective go vernance and data utilization. The proposed framework emphasizes that digital transformation should be evaluated through measurable improvements in information reliability, service acc essibility, operational responsiveness, and user satisfaction.
The framework is consistent with UNESCO's (2023) perspective that educational technology should be evaluated according to its contribution to educational objectives and institutional eff ectiveness.The proposed analysis establishes that improving digital education services require s more than implementing digital platforms. It requires a combination of effective IT governa nce, reliable educational data management, analytical capabilities, and continuous service eval uation.The integration of COBIT 2019 and Big Data Analytics offers a structured approach fo r connecting governance assessment with institutional performance insights. The proposed fra mework is expected to support more accountable, integrated, and sustainable digital education services in Islamic madrasahs.

CONCLUSION.

This study proposes a data-driven IT governance framework integrating COBIT 2019 and Big Data Analytics to improve digital education services in Islamic madrasahs under Indonesia's Ministry of Religious Affairs. The framework connects IT governance capability, educational data management, analytical performance, and digital service quality within an integrated evaluation approach. COBIT 2019 provides a structured mechanism for assessing IT governance, managing technology risks, strengthening information security, and monitoring institutional performance. Meanwhile, Big Data Analytics supports the processing of educational data to identify performance patterns, information gaps, and opportunities for service improvement. The integration of these approaches is expected to strengthen data-driven decision-making, institutional accountability, and operational efficiency. The proposed framework contributes theoretically and methodologically by connecting IT governance assessment with educational data analytics and digital service quality evaluation. Practically, it offers a reference for the Ministry of Religious Affairs and madrasah administrators in establishing more integrated, reliable, and sustainable digital education services. Future research should validate the proposed framework using empirical data from EMIS and other authorized madrasah information systems. Further studies should also evaluate governance capability, data quality, analytical effectiveness, and user satisfaction across different madrasah institutions.

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