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Improving the Quality of Decision-Making in Educational Institutions with Business Intelligence

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Abstract - Effective decision-making in educational institutions depends on accurate, timely, and interpretable information. Nevertheless, many schools and universities still manage academic, financial, attendance, and stakeholder data through disconnected systems, manual reports, and fragmented spreadsheets. This study examines how Business Intelligence (BI) supports the quality of strategic and operational decision-making in educational institutions. A qualitative multiple-case study was conducted in three institutions in West Java, Indonesia: one senior high school, one junior high school, and one private university. Data were collected from 12 purposively selected participants through semi-structured interviews, direct observation of analytical dashboards, and document analysis. The data were analyzed thematically through reduction, open and axial coding, and cross-case comparison, supported by source and method triangulation and member checking. The findings show that BI improved access to real-time indicators of academic performance, attendance, resource allocation, budget realization, and stakeholder satisfaction. Descriptive institutional records indicated that average operational decision time declined from 5.8–7.0 days to 1.2–1.8 days, while the estimated proportion of data-driven decisions increased from 25–40% to 80–90%. BI also strengthened transparency, stakeholder participation, and proactive academic intervention. However, implementation effectiveness remained dependent on digital infrastructure, data integration, staff data literacy, management commitment, and organizational readiness. The study concludes that BI can function as a strategic enabler of responsive and accountable educational governance when technology, people, and institutional policies are developed in an integrated manner.

Keywords:
Business Intelligence;
Decision-Making;
Educational Institutions;
Data-Driven Culture;

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INTRODUCTION

Educational institutions operate in an environment characterized by increasing data volume, greater accountability demands, and the need for rapid responses to academic and managerial problems. Curriculum planning, budget allocation, student intervention, teacher workload distribution, and performance evaluation all require information that is accurate, current, and sufficiently integrated. In practice, however, many schools and universities still rely on disconnected applications, manually consolidated spreadsheets, and periodic reports that reach decision-makers after the relevant situation has changed. These conditions can delay intervention, create inconsistent interpretations, and reduce the efficiency of institutional resources.

Business Intelligence (BI) offers a structured way to transform operational data into information that can support strategic and operational decisions. BI combines data integration, storage, analysis, visualization, and reporting so that leaders can monitor key performance indicators and identify emerging patterns through dashboards and analytical reports [6], [8]. In education, the same capability can be used to track academic achievement, attendance, resource utilization, financial realization, student retention, and stakeholder satisfaction. Educational

data mining and learning analytics have also demonstrated the value of systematic data use for identifying performance patterns and supporting timely intervention [1].

The adoption of BI in educational institutions is not merely a technical installation. Its effectiveness is shaped by data quality, system interoperability, infrastructure availability, staff competence, governance policies, and leadership commitment. Previous work indicates that BI dashboards can support student retention and institutional monitoring [2], while higher education analytics can help institutions move from retrospective reporting toward more proactive decision support [3], [4]. Studies in the Indonesian context likewise highlight the value of dashboards for school management and academic decision-making, but they also identify fragmentation, limited data literacy, and unequal infrastructure as recurring obstacles [5], [7], [9].

A gap remains in understanding how BI contributes to decision quality across different types of Indonesian educational institutions, particularly when secondary schools and universities are examined within the same study. Much of the available discussion concentrates on higher education, technical architecture, or a single institutional case. Less attention has been given to the combined effects of BI on decision speed, transparency, stakeholder participation, proactive intervention, and organizational culture in institutions with different levels of digital readiness.

Accordingly, this study examines the implementation of BI in one senior high school, one junior high school, and one private university in West Java. The study addresses three questions: how BI changes the process and quality of decision-making; what technical and organizational conditions support or constrain implementation; and what practical measures can improve BI adoption in educational institutions. The contribution of the study lies in its cross-case perspective and in the development of practical recommendations for institutions seeking to strengthen data-driven governance with limited and varied resources.

LITERATURE REVIEW

Business Intelligence in Educational Management

BI refers to the coordinated use of data sources, integration processes, repositories, analytics tools, and visualization interfaces to convert raw data into actionable information. In a typical educational setting, data are generated by learning management systems, student information systems, attendance applications, financial systems, human resource records, and stakeholder surveys. BI integrates these sources through extract, transform, and load processes before presenting indicators through reports and dashboards. This architecture helps reduce duplication, improve consistency, and enable leaders to examine institutional performance from a unified perspective [6], [8].

The value of BI is derived not only from the availability of technology, but also from the extent to which information is used in actual management processes. Research on BI utilization associates routine and advanced use with stronger planning, analytical capacity, and managerial decision support [12], [13]. In education, BI can provide early warnings, reveal attendance or achievement trends, support allocation decisions, and facilitate the monitoring of institutional targets [2], [4], [7]. These functions are especially relevant when leaders must coordinate academic and administrative units that previously used different reporting formats.

Data-Driven Decision-Making and Decision Quality

Data-driven decision-making is a management approach in which institutional choices are supported by verified and relevant evidence rather than relying primarily on intuition, incomplete reports, or isolated experience. Decision quality in this study is reflected in four

interrelated dimensions: the relevance and accuracy of information, the speed of response, the transparency of the decision process, and the participation of relevant stakeholders. BI can strengthen these dimensions by providing consistent indicators and traceable data sources. However, dashboards do not automatically produce good decisions; users must understand the data, question anomalies, and relate visualized patterns to the institutional context.

The transition toward data-driven management also involves a cultural change. When teachers, academic managers, administrative staff, and institutional leaders can access the same indicators, decisions become easier to discuss and justify. This shared evidence base may reduce information asymmetry and encourage accountability. At the same time, resistance may emerge when staff perceive data systems as replacing professional judgment or increasing surveillance. Therefore, BI should be positioned as a decision-support mechanism that complements professional expertise, not as a substitute for contextual and ethical judgment.

Technology, Organization, and Institutional Environment

The implementation of BI can be interpreted through three readiness dimensions. The technological dimension concerns infrastructure, connectivity, data quality, system compatibility, security, and the usability of analytical tools. The organizational dimension includes leadership commitment, staff competence, data governance, budget availability, and the alignment of BI with institutional processes. The environmental dimension includes education policy, accountability requirements, technology vendors, and collaboration opportunities. The interaction of these dimensions explains why institutions using similar BI tools may obtain different outcomes.

Based on this literature, the study assumes that integrated data and accessible dashboards can improve decision quality when they are supported by data literacy, clear governance, and management commitment. Conversely, fragmented systems, weak infrastructure, and cultural resistance can limit BI use even when the software is technically available. This conceptual relationship guides the cross-case analysis of BI benefits, implementation conditions, and barriers.

METHODOLOGY

Research Design and Sites

The study employed a qualitative multiple-case study design to examine BI implementation in real institutional settings. Three educational institutions in West Java were selected because they had already used a BI system or analytical dashboard in routine management: one senior high school, one junior high school, and one private university. The cases represented different organizational scales and levels of digital maturity, enabling comparison between common implementation patterns and context-specific conditions.

Participants and Data Collection

Participants were selected through purposive sampling based on their involvement in data management or decision-making. The 12 informants included institutional leaders, academic managers, information technology personnel, administrative staff, and dashboard end users. Data were collected through semi-structured interviews, direct observation, and document analysis. Interviews explored decision processes before and after BI implementation, perceived changes in decision quality, and implementation barriers. Observations focused on dashboard use, indicator interpretation, and data-driven workflows. Documents included management reports, system architecture descriptions, performance indicators, and internal data governance policies.

BI Architecture and Analytical Indicators

The technical review examined four layers of the BI environment: data sources, data integration and transformation, data storage, and analytics and visualization. Data sources included learning management systems, student and teacher databases, financial systems, and digital attendance. The integration layer used extract, transform, and load procedures to consolidate heterogeneous data into a warehouse or educational data mart. The presentation layer used BI tools such as Power BI, Tableau, or institution-specific solutions to display academic, financial, attendance, and satisfaction indicators.

$$\text{Data Utilization Rate (DUR)} = (\text{BI-supported strategic decisions} / \text{total strategic decisions}) \times 100\% \quad (1)$$

$$\text{Time-saving rate} = ((T_{before} - T_{after}) / T_{before}) \times 100\% \quad (2)$$

Equation (1) was used descriptively to summarize the proportion of strategic decisions supported by BI, while Equation (2) summarized the reduction in average operational decision time. These indicators were based on institutional reports and were cross-checked during interviews. They were not used for inferential statistical testing because the study focused on three cases and emphasized contextual interpretation.

Data Analysis and Trustworthiness

The data were analyzed thematically through data reduction, open coding, axial coding, and cross-case interpretation. Codes were grouped into themes such as information relevance, decision speed, transparency, participation, proactive intervention, infrastructure readiness, data literacy, and organizational resistance. A gap analysis compared the ideal BI architecture with actual implementation in each institution. The credibility of the findings was strengthened through triangulation across data sources and methods, as well as member checking with key informants. The focused literature review used publications from 2015–2025 that addressed BI, educational analytics, dashboards, data-driven decision-making, and implementation barriers.

RESULTS AND DISCUSSION

Changes in Decision-Making Practices

Across the three cases, BI changed how leaders obtained and interpreted information. Before implementation, the institutions depended largely on monthly reports, separate spreadsheets, and manual data consolidation. These procedures made it difficult to compare indicators promptly or trace the evidence behind a decision. After BI implementation, leaders could view updated information on academic performance, attendance, teaching loads, budget realization, and stakeholder satisfaction through a common dashboard. Table 1 summarizes the most consistent changes identified across cases.

Table 1. Comparison of decision-making practices before and after BI implementation

Decision-Making Aspect	Before BI Implementation	After BI Implementation
Information sources	Manual reports, separate spreadsheets, and professional intuition	Integrated dashboards with updated and consolidated indicators
Response speed	Data collection and verification required several days or weeks	Relevant information could be accessed within seconds or minutes
Data accuracy	Greater exposure to duplication, inconsistent formats, and input errors	Centralized, validated, and more consistent data

Decision-Making Aspect	Before BI Implementation	After BI Implementation
Stakeholder participation	Information was concentrated in administrative units	Teachers, academic managers, and leaders shared access to selected indicators
Decision orientation	Mostly reactive and routine	More proactive, trend-based, and preventive
Transparency	Evidence supporting decisions was difficult to trace	Visualizations and data logs made the basis of decisions clearer

One school principal explained that the dashboard made it possible to identify academic risk earlier: “Previously, we only discovered that students were at risk of failing near the final examination. Now the BI dashboard provides an early warning when daily scores decline sharply, allowing us to coordinate immediately with homeroom teachers and parents.” This experience illustrates the shift from retrospective reporting to proactive intervention described in the BI and educational analytics literature [1], [4].

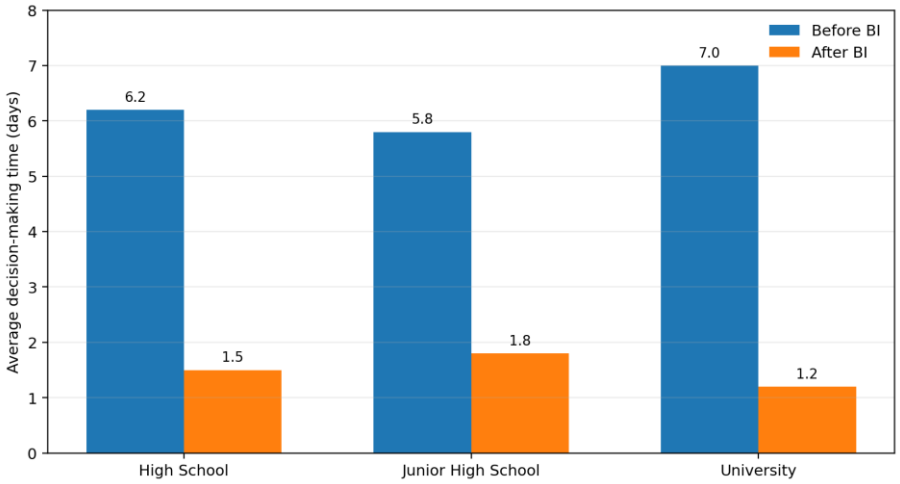
Decision Speed and Operational Efficiency

Descriptive records showed a substantial reduction in the time needed for operational decisions such as schedule adjustments, extracurricular activity approval, and academic intervention coordination. The senior high school reduced average decision time from 6.2 days to 1.5 days, the junior high school from 5.8 days to 1.8 days, and the university from 7.0 days to 1.2 days. The combined average declined from approximately 6.3 days to 1.5 days, representing a time saving of about 76%. Table 2 and Figure 1 present the cross-case comparison.

Table 2. Average operational decision-making time before and after BI implementation

Institution	Before BI (days)	After BI (days)	Time Saving (%)
Senior High School	6.2	1.5	75.8
Junior High School	5.8	1.8	69.0
Private University	7.0	1.2	82.9

Figure 1. Average decision-making time before and after BI implementation

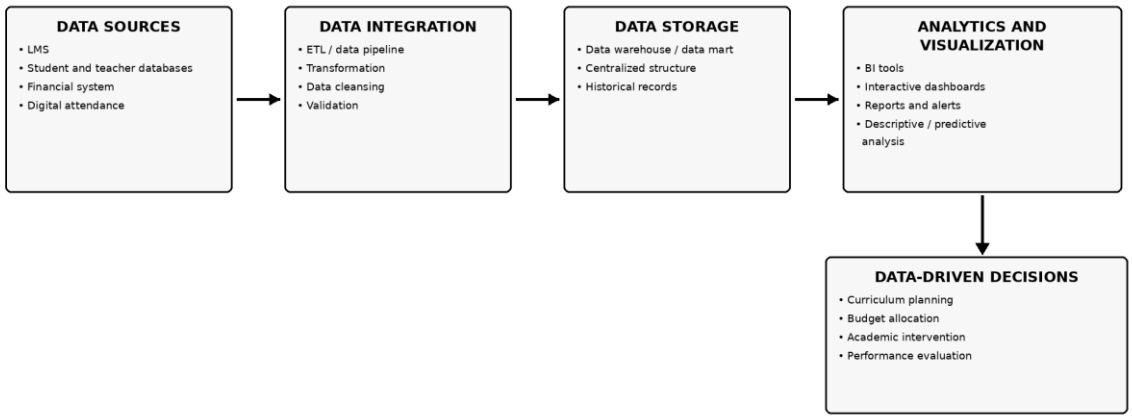


The time reduction did not result solely from faster software. It reflected a shorter information chain: data no longer had to be repeatedly requested, reformatted, and reconciled before a meeting. The effect was most pronounced at the university, where the information technology infrastructure was more mature. The junior high school obtained a smaller, although still substantial, reduction because some data remained dependent on manual synchronization. This variation confirms that BI performance is closely connected to integration quality and organizational readiness, not only dashboard availability [9], [12].

BI Architecture and Data Integration

The three institutions used a broadly similar BI architecture, consisting of operational data sources, an integration process, a centralized repository, and a visualization layer. Figure 2 illustrates the common architecture identified in the cases. The university had the most complete integration between academic, financial, and attendance systems. The two schools used partial integration because attendance and grading applications were supplied by different vendors and did not always use compatible data structures.

Figure 2. Business Intelligence architecture in educational institutions



Even partial integration produced practical benefits because selected indicators could be consolidated and visualized in one place. Nevertheless, incomplete synchronization created a risk that users would compare data generated at different times. The findings support earlier Indonesian studies that identify system fragmentation as a central challenge in school BI implementation [7], [9]. Institutions therefore need clear definitions of data ownership, update frequency, validation responsibility, and access rights before expanding the number of dashboard indicators.

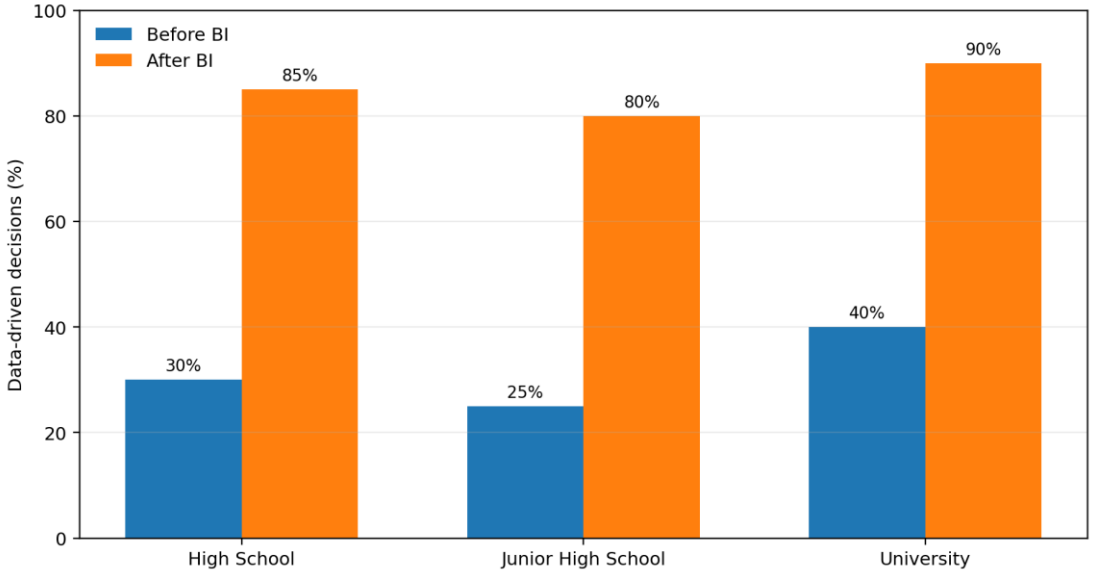
Data-Driven Culture, Transparency, and Participation

BI use was also associated with a marked increase in the proportion of decisions explicitly supported by institutional data. The estimated percentage rose from 30% to 85% in the senior high school, from 25% to 80% in the junior high school, and from 40% to 90% in the university. Table 3 and Figure 3 show the reported change. These percentages should be interpreted as descriptive institutional indicators rather than population estimates, but they provide a consistent picture of the transition toward more evidence-based management.

Table 3. Estimated percentage of data-driven decisions before and after BI implementation

Institution	Before BI (%)	After BI (%)
Senior High School	30	85
Junior High School	25	80
Private University	40	90

Figure 3. Estimated proportion of data-driven decisions before and after BI implementation



Shared dashboards increased the participation of teachers and academic managers because discussions could begin from the same indicators rather than from separate reports. This reduced information asymmetry and made it easier to explain why a particular intervention or allocation was selected. The traceability of visualized data also strengthened accountability. These findings are consistent with studies that position BI as a mechanism for improving planning and managerial coordination [10], [11]. At the same time, participants emphasized that data should inform professional judgment rather than replace it, particularly when decisions involved student welfare or contextual factors not captured in the system.

Implementation Challenges

The benefits of BI were accompanied by four recurring challenges. First, the schools had limited infrastructure and budget for software licensing, server maintenance, and integration development. Second, several administrative staff and teachers could read basic charts but lacked the data literacy required to question definitions, compare periods, or interpret unusual patterns. Third, vendor differences created technical barriers to automated data exchange. Fourth, some senior personnel continued to place greater trust in experience and intuition than in system-generated evidence. These barriers indicate that digital transformation requires changes in capability and organizational routines in addition to technology acquisition [9], [13].

Management commitment was the main condition that distinguished sustained BI use from occasional dashboard viewing. Institutions in which leaders required data to be discussed in planning and evaluation meetings showed more consistent utilization. Conversely, where BI remained an information technology initiative without explicit managerial ownership, dashboard use was narrower. This finding supports the view that BI should be integrated into

institutional governance, performance review, and professional development rather than treated as a stand-alone application.

Practical Recommendations

Based on the cross-case findings, educational institutions should adopt BI gradually. The first stage should identify a limited set of high-priority indicators, clarify data ownership, and standardize definitions. The second stage should integrate the most frequently used systems and establish validation procedures. The third stage should provide role-based dashboards and practical data literacy training for leaders, teachers, and administrative staff. The final stage should embed dashboard evidence into routine planning, monitoring, and evaluation meetings. Institutions with limited budgets may consider cloud-based or open-source tools, provided that data protection, access control, and maintenance responsibilities are clearly addressed.

Collaboration between educational institutions, local technology developers, and cloud service providers may also reduce implementation costs and improve contextual relevance. Dashboard indicators should align with institutional objectives and applicable education policies rather than merely reproduce all available data. In this way, BI can support a realistic transformation pathway that improves management efficiency while preserving professional judgment and educational values.

CONCLUSION

This study shows that Business Intelligence can improve the quality of decision-making in educational institutions by accelerating access to relevant information, strengthening transparency, supporting stakeholder participation, and enabling more proactive academic and operational interventions. Across the three cases, average operational decision time declined from 5.8–7.0 days to 1.2–1.8 days, while the estimated proportion of data-driven decisions increased from 25–40% to 80–90%. The findings demonstrate that BI is not simply a visualization tool; it can become a strategic enabler of responsive and accountable educational governance when integrated with institutional processes.

The effectiveness of BI nevertheless depends on the alignment of technology, people, and organizational commitment. Integrated and validated data, adequate infrastructure, staff data literacy, clear governance policies, and active leadership were necessary for sustained use. The study is limited to three educational institutions in West Java, and the descriptive indicators should not be generalized statistically to all Indonesian institutions. Future research should involve a wider range of public and private schools, madrasas, universities, and institutions in remote or disadvantaged areas. Longitudinal and mixed-method designs are also needed to examine whether improvements in decision processes lead to sustained gains in learning quality, resource efficiency, and public accountability.

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