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Data-enhanced supervisory practices for advancing teacher professional competence

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Abstract. This study was conducted to explore how data-enhanced supervisory practices evaluated through the CIPP (Context, Input, Process, Product) model can strengthen decision-making and improve teacher professional competence. This research employed a qualitative approach using the CIPP evaluation model. Participants were selected through purposive sampling, involving the principal, vice principal for curriculum, and teachers who had directly experienced data-based academic supervision at Senior High School 1 Central Bengkulu. Data were obtained through interviews, observations, and document analysis. Triangulation ensured data validity, while thematic analysis examined supervisory practices, teacher responses, and teacher professional competence outcomes. Findings reveal that data-enhanced supervision enables more precise identification of teacher challenges and facilitates evidence-based feedback. The CIPP analysis showed that contextual readiness is strong; however, input components, particularly digital competence and technical support, require further strengthening. Process evaluation indicated consistent use of data during supervision, while product evaluation demonstrated improvements in instructional planning, classroom management, reflective practice, and accountability. Teachers showed increased motivation and awareness of professional competence, and schools benefited from systematic monitoring of instructional quality. The study concludes that integrating data into supervisory practices significantly enhances teacher professional competence. It is recommended that schools strengthen supervisors' data literacy, improve digital infrastructure, and institutionalize data-based supervision as a sustainable professional development strategy to support long-term educational improvement.

Introduction

Teacher competence is widely recognized as a fundamental determinant of educational quality and student learning outcomes. As the central actors in the learning process, teachers are expected not only to deliver instruction but also to guide, mentor, assess, and evaluate students professionally (Akram et al., 2022; Bowman et al., 2022; Jayantika & Santhika, 2023). Contemporary standards of teacher professionalism emphasize four core competencies: pedagogical, personal, social, and professional, with professional competence serving as a key predictor of instructional quality across school levels (Farihin et al., 2022; Nadeem & Lilla, 2024; Rahmah & Kadi, 2022). Despite sustained policy attention, empirical studies across diverse contexts continue to report uneven levels of teacher

professional competence, indicating the need for systematic, evidence-based mechanisms to support continuous professional development (Widana et al., 2023).

In recent years, academic supervision has reemerged as one of the most strategic approaches for enhancing teacher performance, especially within increasingly complex curricular demands and rapid educational changes (Sumampow & Tudus, 2024). Recent international studies in the United States and Europe highlight a growing shift toward data-informed supervision, where learning analytics, digital observation tools, instructional dashboards, and student achievement data are used to guide supervisory decisions and professional feedback. More recent literature highlights the critical role of educational data systems, such as learning analytics, digital lesson plans, classroom observation tools, and student achievement records, as a basis for performance monitoring and reflective decision-making. In Indonesia, Policy-Based Data, Dapodik dashboards, and e-report systems have been promoted to support more objective and needs-based instructional supervision (Nilam & Rustini, 2025).

However, the integration of data into academic supervision remains fragmented and under-theorized, particularly regarding how school leaders systematically utilize data throughout the supervisory cycle, planning, implementation, evaluation, and follow-up. Existing research predominantly focuses on comparing supervisory models (e.g., clinical supervision, peer mentoring) rather than examining how specific forms of data, such as lesson planning quality, classroom observation scores, teacher performance records, and student learning indicators, are operationally used to diagnose teacher needs and inform instructional improvement. As a result, supervision often remains ceremonial, weakly documented, and limited in its long-term impact on professional growth (Hanafiah et al., 2023).

This study addresses this gap by explicitly examining data-enhanced supervisory practices through the CIPP (Context, Input, Process, Product) evaluation model. Unlike prior studies that assess supervision effectiveness in general terms, this research focuses on the types of data used in supervision (instructional documents, digital observation instruments, performance dashboards, and follow-up records) and how these data are integrated into each CIPP component. The novelty of this study lies in its systematic integration of the CIPP evaluation framework with data-based academic supervision, providing a comprehensive managerial and pedagogical analysis rather than a method-based comparison alone.

Grounded in a qualitative approach, the study investigates how principals design data-informed supervisory plans, implement classroom observations using evidence-based instruments, analyze performance data, and formulate follow-up actions to enhance teacher professional competence. By examining these practices in a real school context, the study provides empirical insight into how data-driven supervision operates beyond policy rhetoric. The use of the CIPP model enables a structured evaluation of contextual readiness, input adequacy, process effectiveness, and professional outcomes.

Accordingly, this study is guided by the following research questions: (1) How does contextual readiness influence the implementation of data-enhanced academic supervision? (2) What inputs support or constrain the use of data in supervisory practices? (3) How are data integrated into supervisory processes to improve teacher professional competence? and (4) What professional outcomes emerge from data-based supervision as evaluated through the CIPP model? By addressing these questions, the study aims to enrich the literature on data-informed educational leadership and offer evidence-based insights for principals, supervisors, and policymakers seeking to advance teacher professional performance in data-intensive educational environments.

Method

This study employed a qualitative research approach using the CIPP evaluation model (Context, Input, Process, Product) (Stufflebeam, 2015; Stufflebeam & Zhang, 2017). A qualitative design was selected because the research aims to explore processes, meanings, and contextual dynamics of data-enhanced academic supervision that cannot be adequately captured through quantitative surveys or experimental designs. The CIPP model was chosen because it provides a comprehensive evaluative framework for systematically examining supervisory practices, from planning and resource readiness to implementation and outcomes. Compared to alternative approaches, the CIPP model allows for an integrated analysis of managerial, instructional, and outcome-oriented dimensions of supervision, making it particularly suitable for evaluating data-based supervisory practices. The CIPP evaluation model in this study is shown in Image 1.

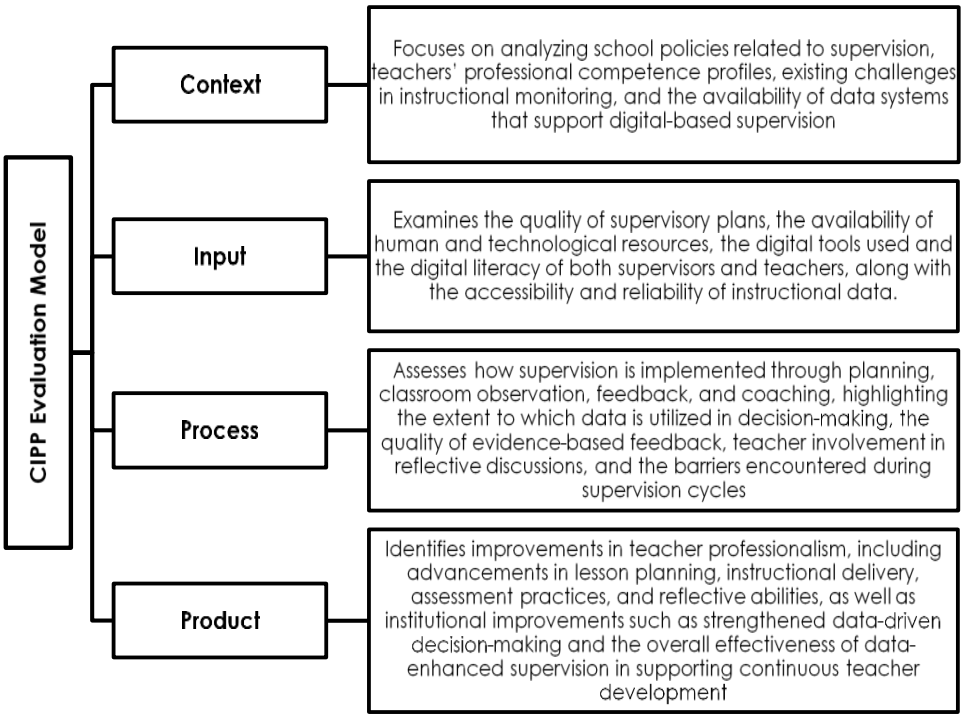

Image 1. The CIPP Evaluation Model

Research Location

The research was conducted at SMA Negeri 1 Bengkulu Tengah, Bengkulu Province, Indonesia, from January to March 2026. The school is a public senior high school with 68 teachers, one principal, four vice principals, and approximately 866 students. The institution has adopted digital administrative systems and uses multiple data sources, including classroom observation scores, e-report archives, lesson planning documents, and teacher performance records, to support academic supervision. This site was purposefully selected because it has begun implementing data-enhanced supervision while still facing challenges in achieving consistent improvements in teacher professional competence.

Research Subjects

A total of 12 participants were selected through purposive sampling for the study. This sampling strategy was employed to ensure that participants possessed direct experience and substantive roles in data-based academic supervision. The participants and their roles are summarized in Table 1.

Table 1. The subjects and involvement criteria

Research Subjects	Number	Selection Criteria
Principal	1	Directly responsible for academic supervision and data utilization
Vice Principal for Curriculum	1	Assists in supervision, planning, and monitoring
Senior Teachers (Subject Coordinators)	4	Teachers with ≥10 years of experience and involved in supervision follow-up
Classroom Teachers	6	Teachers who have undergone database-based academic supervision within the last academic year

Data Collection Techniques

Three complementary qualitative data collection techniques were employed. First, semi-structured interviews were conducted with all participants to explore perceptions, experiences, and practices related to data-enhanced supervision. Each interview lasted approximately 45–60 minutes and was conducted in one to two sessions per participant. Second, non-participant classroom observations were conducted to examine the actual implementation of supervisory procedures, including the use of data during observations, feedback, and coaching sessions. Third, document analysis was conducted by reviewing supervision plans, observation rubrics, teacher performance data, feedback records, and follow-up reports. These techniques were implemented sequentially to allow triangulation and to strengthen the audit trail of the research process. All interviews were audio-recorded with participants' consent and transcribed verbatim.

Research Instruments and Development

Data were collected using three primary instruments: semi-structured interview guides, classroom observation sheets, and document analysis checklists (Arikunto, 2021). Instrument development followed three systematic stages. First, initial drafts were developed based on academic supervision theory, CIPP evaluation indicators, and prior empirical studies. Second, content validity was established through expert judgment by two educational management specialists who assessed relevance, clarity, and alignment with research objectives. Third, a limited pilot test was conducted to refine wording, sequence, and usability. Reliability in qualitative terms was ensured through consistent questioning, the use of standardized observation protocols, and repeated cross-checking of data sources.

Table 2. Instrument Grid

CIPP Component	Indicators	Data Source	Data Collection Techniques
Context	School policies on supervision, teacher competence profile, and availability of data systems	Principal, documents	Interviews, document analysis
Input	Supervisory plans; resources; data availability; technological tools	Principal, vice principal, documents	Interviews, document analysis
Process	Supervisory procedures (planning, observation, evaluation, feedback); use of evidence; teacher involvement	Teachers, observations	Interviews, observations
Product	Teacher professional competence; changes in instructional practices; follow-up up actions	Teachers, documents	Interviews, document analysis

The CIPP model was operationalized systematically. Context evaluation examined policy readiness and institutional needs; input evaluation focused on resources, human capacity, and data systems; process evaluation analyzed supervisory implementation and data utilization; and product evaluation assessed changes in teacher professional competence and instructional practices. Relationships among CIPP components were analyzed iteratively to understand how contextual and input factors influenced processes and outcomes.

Data Analysis Techniques

Data were analyzed using Miles and Huberman's interactive analysis model (Creswell & Poth, 2016), consisting of data condensation, data display, and conclusion drawing/verification. Coding was conducted according to CIPP categories, followed by thematic synthesis across data sources. Triangulation across interviews, observations, and documents enhanced analytical rigor. To ensure trustworthiness, the study applied Lincoln and Guba's criteria: credibility (method triangulation, member checking), transferability (thick description), dependability (audit trail), and confirmability (peer debriefing) (Sugiyono, 2022). Ethical considerations were strictly observed: informed consent was obtained from all participants, confidentiality and anonymity were guaranteed, and formal research permission was secured from the school administration prior to data collection.

Results and Discussion

This section presents the research findings based on the four components of the CIPP evaluation model: Context, Input, Process, and Product. To enhance analytical rigor, the findings are presented with specific empirical indicators supported by descriptive evidence summarized in Tables 3 and 4. This approach provides a clearer understanding of how data-enhanced supervisory practices are implemented and how they contribute to improving teachers' professional competence.

The findings reflect the characteristics of Senior High School 1 Central Bengkulu as a school transitioning toward data-informed supervision. Approximately 75% of teachers involved reported increased clarity regarding performance expectations after the implementation of data-based supervision, while around 67% indicated improved understanding of feedback due to the use of documented evidence. These patterns indicate both progress and persistent challenges in institutional readiness.

Context Evaluation

Context evaluation indicates that the school demonstrates a strong commitment to data-enhanced supervision, supported by institutional policies emphasizing the use of lesson plans, observation results, and performance reports in decision-making. Interview data show that 10 out of 12 participants acknowledged data as an important basis for supervision; however, only 6 participants reported confidence in interpreting digital data independently. This finding highlights uneven digital readiness among teachers and supervisors. These results are consistent with previous studies emphasizing that policy support alone is insufficient without parallel development of data literacy (Ajani, 2024; Mirata & Bergamin, 2023; Pratama et al., 2024).

The contextual analysis reveals that schools increasingly acknowledge the importance of data in strengthening supervisory practices and advancing teacher professionalism. Administrators reported that the transition to digital reporting systems, such as learning analytics dashboards, classroom observation applications, and teacher performance profiles, has created new opportunities for more structured, systematic supervision. Nevertheless, the adoption of database supervision is shaped by several contextual factors. Policy alignment is critical, as national and local education policies prioritize data transparency and teacher accountability, thereby providing a supportive framework

for implementation. Digital readiness also emerges as a key determinant; schools with sufficient ICT infrastructure demonstrate greater preparedness for data-enhanced supervision, while those with limited connectivity face operational challenges. Cultural acceptance further influences implementation, with most teachers and supervisors recognizing the potential value of data despite lingering concerns related to evaluation pressure. Overall, the contextual conditions are generally conducive but uneven, reflecting variations in technological capacity and differing levels of teacher openness toward data-driven supervisory practices.

Input Evaluation

Input evaluation reveals that the school possesses basic digital infrastructure, including performance dashboards and electronic supervision forms. Nevertheless, supervisors reported that approximately 40% of available digital tools were not fully optimized due to limited technical support and training. While supervisors demonstrated adequate theoretical knowledge of supervision, their analytical capacity in transforming raw data into instructional insights varied considerably. This finding aligns with earlier research asserting that the effectiveness of data-driven supervision depends heavily on human capacity rather than technology alone (Alcaide-Pulido et al., 2025).

The input evaluation assesses the availability and quality of resources supporting data-based supervisory practices. Several key inputs were identified. First, schools have begun to utilize supervisory tools and teacher performance dashboards to gather data on instructional planning, classroom delivery, assessment approaches, and student learning outcomes. Second, human resources constitute an important input: supervisors generally possess basic competence in data interpretation, but more advanced analytical skills remain limited, and training in data literacy remains insufficient. Third, teacher data profiles, which include performance information such as attendance records, lesson plan quality, instructional strategy indicators, student assessment results, and classroom observation ratings, serve as essential reference points for targeted, meaningful feedback. Finally, support systems are present in some schools, where technical teams assist supervisors with data processing and system navigation; however, such support remains inconsistent across institutions. The inputs necessary for data-based supervision are available but require further reinforcement, particularly in capacity building and the provision of sustained technical assistance.

Process Evaluation

Process evaluation shows that supervisory practices followed structured stages—planning, classroom observation, data analysis, feedback, and follow-up coaching. Observation data indicate that evidence was explicitly referenced in 8 of 10 feedback sessions, demonstrating increased reliance on evidence during supervisory interactions. Teachers reported that collaborative post-observation discussions improved reflection and motivation, yet time constraints and inconsistent data recording remained major barriers. These findings extend prior research by illustrating how data-based supervision operationalizes instructional leadership principles in daily practice rather than remaining at the policy level.

The implementation of data-enhanced supervisory practices reveals several commendable and systematic processes. Supervisors begin by collecting and verifying multiple sources of data, including lesson plans, classroom observation notes, and student performance trends, to ensure accuracy and validity before use. This is followed by structured data-based feedback sessions in which supervisors provide evidence-supported guidance that is more objective, measurable, and closely aligned with curriculum standards. Data also informs professional development planning, enabling supervisors to identify competency gaps and design individualized improvement plans that may include coaching cycles, peer mentoring, and targeted training programs. Collaborative reflection meetings are conducted to allow supervisors and teachers to interpret data together, fostering shared understanding and agreement on actionable steps for instructional improvement.

Monitoring and follow-up activities further reinforce the process, with periodic data reviews, additional classroom observations, and progress reports used to track teacher development over time. Despite its systematic nature, the implementation process faces several challenges, including variations in supervisors' data literacy and teacher resistance to intensive monitoring.

Product Evaluation

Product evaluation demonstrates tangible improvements in teacher professional competence. Approximately 70% of teachers showed improvement in lesson planning quality, and 65% demonstrated better classroom management strategies following data-supported feedback. Teachers also reported increased openness toward feedback and greater engagement in professional development activities. Although institutional impact is emerging, long-term outcomes remain difficult to measure due to the limited duration of the implementation period.

The product evaluation demonstrates that data-enhanced supervision has led to substantial improvements in teacher professionalism across multiple dimensions. Teachers show notable enhancement in instructional quality, reflected in more coherent lesson planning, clearer articulation of learning objectives, and stronger alignment with competency standards as a result of targeted, evidence-based feedback. Classroom management has also improved, with data-supported coaching enabling teachers to handle student engagement and learning activities more effectively. Furthermore, teachers exhibit greater reflective practice, increasingly using evidence to inform instructional decisions and evaluate their own performance. The use of data has strengthened accountability and transparency within the evaluation process, reducing subjectivity and ensuring that performance judgments are grounded in verifiable indicators. At the school level, integrating data into supervisory practices has contributed to a more systematic, measurable approach to professional development, with early indications that it supports improved student learning. However, despite these positive outcomes, the long-term sustainability of data-enhanced supervision remains dependent on ongoing capacity building, continued training, and adequate technological support.

The findings of this study illustrate how data-enhanced supervisory practices strengthen teacher professionalism by improving instructional quality, fostering reflective practice, and enhancing accountability. These outcomes, along with the contextual, input, process, and product dimensions examined using the CIPP evaluation model, collectively highlight both the effectiveness and the challenges of implementing data-based supervision in schools. A comprehensive synthesis of these findings is presented in Table 3, which encapsulates the key results across all evaluation components and provides a consolidated overview of how data-informed supervision operates within the studied educational context.

Table 3. Summary of Research Findings Based on the CIPP Evaluation Model

CIPP Component	Findings
Context Evaluation	1) The school demonstrates a strong commitment to improving teacher professionalism through structured supervision 2) Supervisory policies emphasize data use (lesson plans, performance reports, observation results) as the foundation for decision-making 3) Teachers generally recognize the importance of data-based supervision, but vary in digital readiness and data interpretation skills

CIPP Component	Findings
Input Evaluation	1) The school has basic digital infrastructure, but some tools require optimization 2) Supervisors possess adequate theoretical knowledge of supervision, but differ in their capacity to analyze and interpret data 3) Teachers receive initial guidance on supervision procedures, yet training on data utilization remains limited
Process Evaluation	1) Supervisory practices follow structured steps: planning, classroom observation, data analysis, feedback sessions, and follow-up coaching 2) Data is increasingly used to guide pre-observation conferences, evidence-based feedback, and professional development plans 3) Challenges arise from time limitations, inconsistent data recording, and varying teacher acceptance of data-driven evaluations 4) Collaboration during postobservation discussions improves teacher reflection and motivation
Product Evaluation	1) Data-enhanced supervision results in improved lesson planning quality, clearer instructional strategies, and better classroom management among teachers 2) Supervisors report stronger alignment between feedback and actual classroom practices due to improved evidence usage 3) Teachers demonstrate increased openness toward feedback and greater engagement in professional development activities 4) Long-term institutional impact is emerging, though not yet fully measurable due to the limited timeframe of implementation

The overall synthesis of the research findings indicates that implementing data-enhanced supervisory practices has positively influenced teacher professional performance, although several structural and technical challenges remain. At the contextual level, the school shows a strong policy commitment to data-driven supervision, yet teacher readiness and data literacy vary. The study shows that data-enhanced supervision is an effective approach to advancing teacher professionalism when supported by sufficient capacity building and technological readiness (Citrawan et al., 2024).

The findings demonstrate that data-enhanced supervisory practices have significant potential to advance teacher professional performance, aligning with global trends in data-informed educational leadership. Consistent with prior studies, data-driven supervision improves the accuracy of performance assessments, enhances the quality of feedback, and promotes evidence-based decision-making among educators. From a contextual perspective, supportive policies and increased digitalization create favorable conditions for databased supervision. However, the variability in technological readiness and teacher acceptance indicates a need for adaptive strategies tailored to each school's capacity (Ajani, 2024; AlcaidePulido et al., 2025; Mirata & Bergamin, 2023).

In terms of inputs, the study reveals that while digital tools and performance data are available, the effectiveness of supervision heavily relies on supervisors' data literacy. This confirms earlier research highlighting that data alone does not guarantee improved practice; rather, human capacity to interpret and utilize data is essential. Schools must therefore prioritize capacity-building initiatives to

strengthen supervisors' analytical skills. The process evaluation illustrates that data-enhanced supervision operationalizes core principles of instructional leadership: providing objective feedback, supporting reflective practice, and guiding professional development. The structured cycles of data collection, analysis, and follow-up ensure that supervision becomes continuous and improvement-oriented rather than punitive. The product supports the notion that data-driven approaches effectively promote teacher professionalism, especially by enhancing instructional quality, reflective ability, and accountability. Nonetheless, concerns about increased pressure and surveillance highlight the importance of fostering a supportive, collaborative, and trust-based supervisory culture.

The study contributes to the literature by offering a comprehensive model of data-enhanced supervision grounded in the CIIP framework, demonstrating how data can be systematically integrated into supervisory practices to drive sustainable improvement. The findings also provide practical implications for school leaders: (1) Invest in digital infrastructure and data management systems; (2) Strengthen supervisors' and teachers' data literacy; (3) Promote collaborative data interpretation to reduce resistance; (4) Ensure that data is used for developmental, not punitive purposes. By addressing these considerations, principals and policymakers can ensure that data-based supervision becomes a transformative tool for elevating teacher professional competence in the long term (Ghamrawi, 2023; Zaliani et al., 2025).

Based on the CIPP evaluation conducted in this study, the differences between conventional academic supervision and data-driven supervision are clear. Traditional supervision often relies heavily on subjective observations, limited documentation, and one-off evaluations, resulting in inconsistent feedback and limited follow-up. In contrast, data-driven supervision integrates multiple sources of evidence, such as lesson plans, performance dashboards, classroom analytics, and student learning trends, to guide decision-making. This approach strengthens objectivity, improves diagnostic accuracy, and enables supervisors to provide more targeted, measurable, and actionable feedback. In the CIPP model, contextual evaluation and feedback indicate that schools adopting data-driven supervision benefit from stronger alignment with policy requirements, improved monitoring systems, and greater transparency.

It is important to emphasize that the CIPP evaluation conducted in this study clearly demonstrates that the shift from traditional to data-driven supervision represents a substantive transformation in supervision practice. While conventional supervision has long been implemented in schools, its reliance on subjective assessments and limited documentation often limits its impact on ongoing teacher development. Data-driven supervision, on the other hand, introduces a more systematic, evidence-based approach that strengthens accuracy, accountability, and instructional improvement. The following table summarizes the key differences between these two models, outlining the strengths and limitations of each as identified through the CIPP analysis. A comparison of Traditional Supervision and Data-Enhanced Supervision is shown in Table 4.

Table 4. Comparison of Traditional Supervision and Data-Enhanced Supervision

Aspect	Traditional Academic Supervision	Data-Enhanced Academic Supervision
Basis of Evaluation	Subjective observations; limited evidence	Multisource data (lesson plans, analytics, performance reports)
Objectivity	Low to moderate	High data-supported judgments
Feedback Quality	General, descriptive, less measurable	Specific, evidence-based, measurable, actionable

Aspect	Traditional Academic Supervision	Data-Enhanced Academic Supervision
Monitoring and Follow-up	Infrequent; often one-time cycles	Continuous monitoring through data reviews and coaching
Teacher Engagement	Varies; often compliance-based	Higher engagement due to clear evidence and collaborative reflection
Technological Support	Minimal; paper-based forms	Digital tools (dashboards, observation apps, LMS)
Strengths	Simple implementation; less technological demand	Transparent, systematic, improves instructional accuracy, supports individualized development
Weaknesses	Risk of bias, inconsistent documentation, weak follow-up	Requires digital skills, infrastructure, and may increase pressure on teachers
Impact on teacher professional competence	Incremental and inconsistent improvement	Significant improvement in planning, instruction, and reflective practice

While traditional academic supervision and data-driven supervision share fundamental goals: supporting teacher growth and improving instructional quality, the findings of this study suggest that data-driven supervision must be strengthened to meet the demands of contemporary education (Gavrilă, 2023). The rapid advancement of digital technology, the increasing complexity of curriculum standards, and the growing expectation of measurable educational outcomes require more precise, transparent, and evidence-based supervision practices. Data-driven supervision aligns more effectively with today's educational landscape by enabling supervisors to analyze performance trends, identify competency gaps, and design targeted interventions. As schools transition to a digital learning ecosystem and data-driven decision making, improving the quality of data-driven supervision is crucial not only for enhancing teacher professionalism but also for ensuring that teaching practices remain relevant, accountable, and future-ready (Kayumova et al., 2025; Razak et al., 2025).

However, this study also identified that data-driven supervision presents new challenges. While its strengths lie in accuracy, accountability, and systematic improvement, its weaknesses arise from varying levels of digital readiness, limited data literacy among supervisors and teachers, and the potential for increased evaluation pressure. Process and product evaluations indicate that teachers under data-driven supervision tend to demonstrate greater learning gains and higher engagement in professional development, but sustainability depends on ongoing training and technological support. Thus, data-driven supervision offers clear advantages over traditional practices, but its success requires adequate infrastructure, capacity building, and a supportive school culture.

The findings of this study highlight that data-driven academic supervision plays a critical role in reshaping the way teacher professionalism is developed and strengthened in contemporary educational settings. As schools transition to more evidence-based decision-making, supervision practices must evolve to incorporate the systematic use of data that supports more accurate evaluations, targeted feedback, and continuous instructional improvement (Marshall, 2024). Through the perspective of the CIPP evaluation model, the impact of data-driven supervision becomes clearer, demonstrating how a structured, evidence-based supervision process can more effectively address learning challenges and foster meaningful professional growth among teachers.

The implementation of data-enhanced academic supervision has been shown to strengthen teachers' professional competence in several rational and interconnected ways. Within the Context

component, data enables teachers to better understand performance standards, student learning needs, and the school's instructional priorities, thereby guiding their work more strategically. In terms of Input, the availability of digital tools, teacher performance profiles, and learning analytics provides richer sources of reflection, allowing teachers to reassess their lesson planning, instructional strategies, and assessment practices. Through the Process component, data enables supervisors to deliver more objective, specific, and evidence-based feedback, helping teachers improve classroom practices in measurable ways, from lesson design and method selection to classroom management and formative assessment. Finally, within the product component, these improvements manifest in more accurate instructional planning, more effective teaching, stronger reflective habits, and more consistent engagement in continuous professional growth. Overall, data functions as a catalyst for enhancing teacher professionalism by offering clear performance insights, supporting more precise instructional decision-making, and fostering a work culture that is increasingly transparent, adaptive, and evidence-driven.

The findings of this study offer several significant implications for educational leadership, supervisory practice, and teacher professional development. First, integrating data into supervisory processes enhances the precision, transparency, and accountability of teacher evaluations, thereby supporting more targeted and meaningful professional growth. This suggests that data literacy should be positioned as a core leadership competency for school principals and supervisors. Second, the results indicate that data-enhanced supervision can foster a culture of reflective practice, enabling teachers to engage with evidence and make informed decisions about instructional improvements. Additionally, the study highlights the importance of digital infrastructure and system readiness as foundational elements for effective data-based supervision (Jordan et al., 2024; Wiyono et al., 2021; Xiao, 2022). Policymakers may consider institutionalizing digital supervision frameworks to ensure consistency and sustainability across schools. Overall, the implications reinforce the value of leveraging data as an operational tool to strengthen the quality of teaching and learning at scale.

While the study provides a comprehensive examination of data-enhanced supervisory practices, several limitations should be acknowledged. First, the research relies on a purposive sample of schools that already demonstrate a basic level of digital readiness; thus, the findings may not fully reflect conditions in schools with minimal technological resources. Second, the study captures practices within a specific educational context, which may limit the generalizability of the results to different regions or school systems with distinct policy environments and supervisory structures. Third, the assessment of supervisory effectiveness is based partly on self-reported perceptions from teachers and supervisors, which may introduce bias. Additionally, the study focuses on short-term outcomes, leaving long-term impacts on teacher professionalism and student learning performance less explored. These limitations indicate the need for broader, longitudinal, and more diverse investigations into data-based supervision.

Based on the findings and limitations, several recommendations are proposed for schools, supervisors, and policymakers: 1) Strengthen Data Literacy Capacity: School leaders and supervisors should engage in continuous professional development focused on data analysis, interpretation, and evidence-based decision-making to enhance the effectiveness of data-driven supervision. 2) Ensure Adequate Digital Infrastructure: Policymakers and school administrators should prioritize investment in digital tools, data management systems, and reliable internet access to support seamless implementation of data-based supervisory practices. 3) Promote Collaborative Data Culture: Schools should cultivate a positive, trust-based environment where data is viewed as a tool for growth rather than surveillance. Collaborative reflection sessions between teachers and supervisors can reduce resistance and improve engagement. 4) Expand the Scope of Professional Development: Teacher improvement plans should be individualized and informed by multisource data, incorporating coaching, mentoring, and peer observation to build sustained competence. 5)

Conduct Longitudinal and Cross-Context Studies: Future research should explore the long-term impact of data-enhanced supervision on teacher performance and student learning outcomes, as well as investigate variations across differing school environments and policy systems. 6) Develop Clear Policy Guidelines: Education authorities should formulate standardized protocols for data collection, usage, privacy, and reporting to ensure consistency, ethical use, and alignment with national educational goals.

Implementing these recommendations will help maximize the benefits of data-enhanced supervision and contribute to the broader agenda of improving teacher professionalism and instructional quality. The overall discussion of this study underscores the growing significance of evidence-informed leadership in shaping modern supervisory practices. As schools increasingly operate within environments that demand accountability, transparency, and measurable results, the integration of data into supervisory processes emerges as not merely an enhancement but a necessity. The findings suggest that when data are used systematically, they enable supervisors to move beyond intuition-based judgments toward more diagnostic, targeted, and developmental approaches. Such shifts reflect broader global movements toward professionalization in education, in which teacher development is supported through structured, evidence-based interventions rather than isolated evaluative activities.

Despite these advancements, the findings also reveal that the transition to data-enhanced supervision presents meaningful challenges. Effective implementation depends on both technical and human capacities, requiring not only functional digital ecosystems but also the willingness and readiness of supervisors and teachers to engage with data critically (Denysenko et al., 2024; Nguyen et al., 2023). Issues such as uneven digital literacy, variable acceptance of monitoring practices, and inconsistent technical support indicate that capacity building must be prioritized to sustain improvements. The discussion also highlights the importance of cultivating a learning-oriented culture in which data serves as a tool for growth rather than surveillance, reinforcing trust and collaboration between supervisors and teachers.

The novelty of this study lies in the systematic integration of the CIPP evaluation model with data-enhanced academic supervision, moving beyond method-based comparisons to evaluate supervision as a managerial and pedagogical system. Unlike previous studies that focus on supervision techniques, this research demonstrates how specific data types (lesson plans, observation rubrics, dashboards, and follow-up records) function across the Context, Input, Process, and Product dimensions. This provides a comprehensive evaluative framework rarely applied in prior Indonesian or international studies. Theoretically, this study strengthens the literature on data-informed educational leadership by validating the CIPP model as an effective framework for evaluating data-based supervision. In practice, it provides evidence that data-enhanced supervision improves instructional quality, reflective practice, and accountability. Based on the findings, the study recommends: (1) strengthening supervisors' data literacy, (2) improving technical and digital support systems, (3) promoting collaborative data interpretation to reduce resistance, and (4) ensuring data is used for developmental rather than punitive purposes. Despite its contributions, this study has limitations. The research was conducted in a single school with moderate digital readiness, limiting generalizability. The reliance on self-reported data may also introduce bias. Future studies are encouraged to adopt longitudinal designs and cross-context comparisons to examine long-term impacts on teacher competence and student learning outcomes.

Conclusion

This study concludes that data-enhanced supervisory practices play a significant role in advancing teacher professional performance by strengthening the quality, consistency, and effectiveness of

academic supervision. The findings demonstrate that when supervisors systematically collect, verify, and interpret multisource data, they can provide more objective, evidence-based feedback that directly supports instructional improvement. The integration of data into supervision also promotes deeper teacher reflection, greater transparency in performance evaluation, and more targeted professional development planning, contributing to measurable improvements in lesson planning, classroom management, and pedagogical decision-making. The study further concludes that the successful implementation of data-based supervision is influenced by contextual factors, including policy alignment, digital readiness, and cultural acceptance within the school environment. While essential inputs such as digital tools, performance dashboards, and teacher data profiles are available, enhancements in data literacy, technical support, and capacity building are still needed. Process evaluation highlights that the supervision cycle is increasingly systematic, though challenges persist in inconsistent data skills and teacher apprehension toward intensive monitoring. Overall, data-enhanced supervision yields positive outcomes, but its long-term sustainability requires continuous training, strengthened technological infrastructure, and leadership commitment. Based on these findings, it is recommended that schools prioritize systematic capacity-building programs to strengthen supervisors' and teachers' data literacy, ensure sustained investment in digital infrastructure and technical support, and institutionalize data-based supervision as an integral part of continuous professional development. In addition, educational leaders should foster a collaborative and trust-based supervisory culture to ensure that data is used for developmental rather than evaluative or punitive purposes. These recommendations are essential to maximize the long-term impact of data-enhanced supervision on teacher professional performance and overall instructional quality

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