Multidiciplinary Output Research For Actual and International Issue (MORFAI Journal) | ISSN (e): 2808-6635
Volumes 5 No. 4 (2025)

HYBRID DIGITAL-ADAPTIVE SUPERVISION FOR STRENGTHENING PROFESSIONAL KNOWLEDGE IN USE AND TEACHER PROFESSIONALISM IN THE ERA 5.0

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Received	: 10 September 2025	Published	: 28 September 2025
Revised	: 20 September 2025	DOI	: https://doi.org/10.54443/morfai.v5i4.3817
Accepted	: 24 September 2025	Link Publish	: https://radjapublika.com/index.php/MORFAI/article/view/3817

Abstract

This study aims to examine the effectiveness of integrating digital supervision and the adaptive approach to strengthening Professional Knowledge in Use (PKiU) and enhance teacher professionalism in junior high schools within the Society 5.0 era. A descriptive qualitative approach with a multi-site case study design was used. Data were collected through semi-structured interviews, observations, and document analysis, then analysed thematically to explore supervisory practices in three junior high schools. Integrated digital and adaptive supervision accelerates reflective practices, delivers personalized guidance, and fosters applicable PKiU development. Effectiveness depends on digital infrastructure, leadership, and culture, with challenges including digital literacy gaps and bureaucratic barriers. This study benefits educational management, teacher professional development, supervision policy design, and technology integration in schools, especially in contexts adopting Society 5.0 principles and digital transformation in education. The study introduces a hybrid supervision model combining digital tools with adaptive approach, providing a flexible, context-sensitive framework tailored to diverse teacher needs and digital literacy levels, advancing theory and practice in modern educational supervision.

Keyword: ***Digital Supervision, Adaptive Approach, Professional Knowledge In Use, Teacher Professionalism, Society 5.0 Era***

Introduction

The rapid development of technology and the increasingly complex of education in the Society 5.0 era demand a re-evolution of instructional supervision practices in schools. Traditionally, educational supervision has often been perceived as a hierarchical and bureaucratic process that emphasizes administrative compliance over the continuous development of teachers' professional capacity (Glickman, C. D., Gordon, S. P., & Ross-Gordon, 2001). However, recent developments indicate that the type of supervision needed today must be dynamic, context-responsive, and digitally integrated in order to support more meaningful and sustainable professional growth for teachers (Zepeda Sally J, 2013). Society 5.0 represents an era of collaboration between humans and technology, focusing on innovation driven by Artificial Intelligence (AI), the Internet of Things (IoT), and digitalization, with humans at its core (Kagermann H et al., 2013). In this context, instructional supervision must adapt by leveraging AI and IoT technologies to enable adaptive efficiency, data-informed decision-making, and leadership that addresses ethical and sustainable education transformation holistically (Ramírez-Márquez et al., 2024).

One of the practical issues faced by many schools today is the inability of conventional supervisory systems to address the diverse needs and goals of the teachers' professional development. The dominant approaches still emphasize documentation and administrative assessment, which often fail to stimulate reflective practice, collaboration, or personalized feedback. In response to this, an adaptive supervisory approach has emerged, which emphasizes situational analysis and flexibility in supervisory practices. Meanwhile, digital transformation in school environments has opened new opportunities for supervision, such as real time feedback, remote mentoring and data driven decision making (Japeth Noel et al., 2023). However, the integration of digital supervision with contextually adaptive strategies remains underexplored, particularly in Indonesian lower secondary school contexts. Previous studies have shown that effective instructional supervision can significantly enhance teaching quality and teacher

professional development (Sergiovanni, 1987) Owusu-Addo et al., 2022).Emphasizes the importance of aligning supervision approaches with teachers' readiness and motivation. (Zepeda Sally J, 2013)also argues that instructional supervision should serve as a form of pedagogical leadership rather than merely a tool for compliance evaluation. In the Indonesian context, Wiyono et al. (2021) found that collegial, formative, and flexible approach to supervision tend to be more effective in improving teacher professionalism that top-down approaches, During the COVID-19 pandemic, digital-based supervision emerged as an alternative solution, with studies Japeth Noel et al. (2023) and Rakefet Weidberg & Ciprian Ceobanu (2024) demonstrating that the use of video, digital portfolios, and asynchronous mentoring can enhance teacher autonomy and collaboration.

Nonetheless, the implementation of these approaches still faces significant challenges. Many schools struggle with infrastructure limitations, low digital literacy among supervisors, and work cultures still oriented toward formality and administrative compliance. Moreover, while the adaptive approach is theoretically appealing, its practical implementation remains limited due to supervisors' insufficient capacity to diagnose contextual factors and make adaptive decisions. Existing research also tends to separate studies on digital supervision (Namubiru Ssentamu et al., 2020). From those on differentiated supervision Sergiovanni (1987), with few efforts to systematically integrate both into a cohesive framework.

To address this gap, this study introduces a hybrid supervisory approach called "The Next Supervision" an approach that combines digital tools with adaptive flexibility in the implementation of educational supervision. The concept of "Professional Knowledge in Use" M Eraut (2002) is used as a theoretical foundation to assess how supervision can contribute to the development of practical, contextual, and evolving professional knowledge among teachers. Unlike conventional supervision, which often focuses on checklists and administrative evaluations, this approach seeks to facilitate personalized feedback collaborative reflection, and continuous development tailored to the unique characteristics of each school and teacher. As part of this study, a preliminary investigation was conducted in three public junior high schools in Probolinggo Town: SMP Negeri 1 Probolinggo, SMP Negeri 5 Probolinggo, and SMP Negeri 10 Probolinggo. These schools were purposively selected due to their distinct but complementary characteristics in practicing digital and adaptive supervision.

SMP Negeri 1 Probolinggo is known for its high academic achievement and a strong culture of teacher collaboration under inspirational leadership. Interview revealed that the teachers work with high levels of responsibility and sincerity. More than 50% of the teachers and the principal received "Excellent" performance ratings. The collaborative spirit in addressing learning challenges and sharing practices makes this school a model for others, including schools from outside the town. In terms of digital supervision, SMP Negeri 1 Probolinggo has also begun utilizing the government's digital platform for performance management "Ruang GTK". Through this platform, teachers can independently plan, evaluate, and reflect on the implementation of classroom teaching practices. They also design follow-up action plans based on observation results and engange in self-directed learning based on their specific needs, making extensive use of "Professional Knowledge in Use". Teachers are encouraged to share best practices, lesson plans, real actions, and innovations, while also joining national learning communities to exchange inspiration and assess students through this integrated digital ecosystem.

SMP Negeri 5 Probolinggo also demonstrates excellence, particularly in its implementation of digital supervision. Interviews with school leaders and teachers revealed a highly professional work culture, strong teacher collaboration, and a firm yet visionary leadership style that encourages discipline and innovation. The use of digital platforms such as e-supervision based on web has become routine. The school also has the highest academic performance index in the town, with a highly organized and efficient administrative and management system. This makes SMP Negeri 5 Probolinggo a prime example of integrating digital supervision with collegial collaboration. Furthermore, teachers and leaders in SMP Negeri 5 Probolinggo actively utilize the Ruang GTK platform to manage teaching performance, allowing them to systematically the platform. The ability to connect with professional learning communities across Indonesia further supports teacher growth, while the platform serves as a hub for collaboration, reflection, and knowledge sharing that aligns with the school's collegial culture.

SMP Negeri 10 Probolinggo offers an interesting case of a school in the process of strengthening its supervisory practices, particularly in adaptive and participatory aspects. The principal demonstrates a strong drive for change, supported by teachers' intrinsic motivation and an active learning culture among both students and teachers. Parents, many of whom have a higher education background, show significant involvement in their children's education. While digital supervision is not yet well-established, initiatives such as using google classroom for teacher collaboration have been started. The school is also starting to adopt the Ruang GTK platform as part of its digital supervision initiative. Though still in its early stages, teachers are gradually exploring how to use the platform for planning, self-reflection, learning documentation, and peer collaboration. With strong parental support

and a developing culture of innovation, SMP Negeri 10 Probolinggo holds promising potential for context based, adaptive digital supervision.

Each school presents a rich empirical setting for exploring how "The Next Supervision" can be effectively adapted and applied. SMP Negeri 1 Probolinggo and SMP Negeri 10 Probolinggo exhibit strengths in contextually adaptive supervision, while SMP Negeri 5 Probolinggo excel in digital supervision. This combination of strengths provides a valuable opportunity to analyse how these two supervisory dimensions "digital and adaptive" can complement each other in fostering teacher professionalism. The novelty of this study lies in its conceptual and empirical exploration of a hybrid supervisory approach that combines digital innovation with situational responsiveness. While previous research has typically addressed digital supervision and adaptive or contextual supervision as separate domains, this study introduces a unique integrative framework that highlights the synergy between technological tools such as digital platforms, AI-supported feedback, and data analytics and human-centered flexibility in responding to diverse teacher needs and school contexts. This hybrid supervisory approach is anchored in the values of Society 5.0, in which human capability and technological advancement co-evolve to address complex educational challenges through ethical, sustainable, and innovation-driven practices. By conducting fieldwork in three junior secondary schools with varied institutional cultures, technological readiness, and leadership characteristics, the study provides a robust, multi-site empirical foundation that supports both theoretical development and practical application.

The contributions of this study are threefold: 1) conceptually, it bridges the gap between digital transformation and professional judgment in supervision by proposing a model that integrates innovation with contextual responsiveness; 2) empirically, it demonstrates how integrated digital and adaptive supervision fosters the development of Professional Knowledge in Use, enhances teacher reflection, and improves professionalism in real-world contexts; 3) practically, it offers a scalable and adaptable supervisory modal for diverse educational settings, supporting schools and teachers as they navigate the demands of a dynamic, data-driven, and ethically grounded learning environment. In addition, the study offers practical recommendations for principals, instructional supervisions, and policymakers who seek to move beyond compliance-based supervision toward more transformative, reflective, and future-oriented approaches. The findings are expected to serve as a strategic reference for designing supervisory systems that are not only digitally empowered and contextually adaptive, but also pedagogically meaningful, ultimately contributing to the cultivation of reflective, independent, and professional teachers equipped to thrive in the era of Society 5.0. Thus, the central research question of this study is "How can the integration of digital supervision and the "It depends" approach support the development of Professional Knowledge in Use among junior secondary school teachers and enhancing teacher professionalism in the era of Society 5.0?". Specifically, this study aims to:

1. Analyse the implementation of digital-based supervision in different school context;
2. Examine how supervisory practices are adjusted to teachers' needs and school contexts;
3. Explore the role of integrating digital and adaptive supervision in shaping contextual and applicable professional knowledge among teachers;
4. Analyse the contribution of integrated digital and adaptive supervision to enhancing teacher professionalism in the era of Society 5.0.

Method

This study employed a descriptive qualitative approach with a multi-site study design to explore how the integration of digital supervision and the adaptive "It Depends" approach can support the development of Professional Knowledge in Use among junior high school teachers. This design was chosen for its ability to provide in-depth answer to the research questions, particularly regarding variations in supervision practices across different school contexts. The multi-site approach allowed for a deeper understanding of the unique characteristics of each school and for identifying both common and distinct patterns in the implementation of supervision (Merriam & Sharan B, 1998). The study was conducted at three public junior high schools in Probolinggo town: SMP Negeri 1 Probolinggo, SMP Negeri 5 Probolinggo, and SMP Negeri 10 Probolinggo. These schools were purposively selected based on their strengths and the diversity of their supervision contexts. SMP Negeri 1 Probolinggo is known for its collaborative culture and reflective leadership; SMP Negeri 5 Probolinggo is distinguished by its effective use of digital technology for learning management and supervision; and SMP Negeri 10 Probolinggo represents a school in the process of developing adaptive and participatory supervision practices. Data were collected using three primary techniques: 1) semi-structured in-depth interviews; 2) non-participant observation in classrooms and supervision forums; and 3) document analysis. Interviews were conducted to explore the perceptions, experiences, and challenges faced by

teachers and school leaders in implementing hybrid supervision. The interview guide was developed based on the research focus and validated by two experts in educational supervision.

Society 5.0 is an era of human-technology collaboration that emphasizes innovation driven by Artificial Intelligence (AI), the Internet of Things (IoT), and digitalization, with humans placed at the centre of progress. In the realm of management, including educational and supervisory management, this era demands adaptive efficiency, data-driven decision-making, and leadership capable of addressing ethical, sustainability, and digital transformation challenges holistically. Accordingly, the data collection methods in this study were designed to capture supervisory dynamics that align with the demands of Society 5.0. Observations were employed to document real-time supervisory practices, including authentic interactions between teachers and supervisors, as well as the integration of digital platforms in supervision and performance management processes. This included the use of government-sponsored platforms such as "Ruang GTK" for teacher performance management and "Ruang Guru" as a digital learning and professional development tool. In addition to observations, document analysis was conducted on supervision reports, lesson plans, teacher reflection notes, and performance data obtained from digital platforms. All data collection procedures were carried out ethically, with informed consent obtained from all participants, in accordance with research ethics and respect for individual autonomy in the digital era.

The data were analysed thematically using the interactive model Miles&Huberman (1994), which includes three main stages: data reduction, data display, and conclusion drawing or verification. Coding was conducted manually to identify patterns related to the integration of technology, the flexibility of supervision approaches, and the development of professional teacher knowledge. Cross-case analysis was then performed to compare findings across schools and trace the influence of contextual factors. Data credibility was ensuring through various techniques, including source and method triangulation, member checking with informants, and the use of an audit trail to document the research decision-making process transparently. All interviews were transcribed verbatim and analysed iteratively in relation to the conceptual framework of adaptive supervision and teacher professional development. This study involved human subjects, including school principals, vice principals, teachers, and supervisors from three junior high schools in Probolinggo, East Java, Indonesia. All research procedures were conducted in accordance with established ethical standards for qualitative research. All participants were fully informed about the purpose and procedures of the study, and gave their informed consent prior to participation. Confidentiality and anonymity were assured throughout the data collection and reporting processes. Since this was a non-interventional qualitative study using interviews, observations, and document analysis, ethical approval was obtained from the appropriate academic and institutional authorities. The study also followed national regulations on research ethics in education, and no vulnerable groups were involved. Upon request, supporting documentation regarding informed consent and ethics clearance can be provided.

Results and Discussion

Implementation of Digital Supervision in Various School Contexts

Across all three case study schools SMP Negeri 1 Probolinggo, SMP Negeri 5 Probolinggo, and SMP Negeri 10 Probolinggo, there is consistent use of government-supported digital platforms, namely Ruang GTK and Rumah Pendidikan, both of which are integrated with Artificial Intelligence (AI) features. While the overall level of digital supervision integration varies, SMP Negeri 5 Probolinggo leading with advanced use of Google Workspace, Google Meet, Website, e-supervision and real-time analytics, SMP Negeri 1 Probolinggo utilizing WhatsApp and Google Docs for communication and reflection, and SMP Negeri 10 Probolinggo still developing digital capabilities, the shared adoption of Ruang GTK and Rumah Guru demonstrates a common foundation for supervision enhancement across these schools. These government platforms provide AI-powered functionalities such as automated performance analysis, personalized learning recommendations, and streamlined administrative processes, supporting the supervision process in alignment with the Society 5.0 paradigm. This paradigm emphasizes the collaboration between humans and technology, leveraging AI, the Internet of Things (IoT), and digitalization with humans at the core. By integrating these tools, SMP Negeri 1 Probolinggo, SMP Negeri 5 Probolinggo and SMP Negeri 10 Probolinggo not only improve efficiency and accuracy in supervision but also foster active, reflective engangement from teachers, positioning them as central agents of innovation and quality improvement in education.

Table 1. Level of Digital Supervision Implementation and AI Integration in Three School

School Name	Digital Tools Used	Integration Level	Characteristics
SMPN 5	School Website, Google Workspace, Google Meet, Ruang GTK, Rumah Pendidikan, and all of them	High	Real-time reporting, e-supervision, digital coaching, data-driven feedback and analytics, AI-powered features
SMPN 1	Medium School Website, WhatsApp, Google Docs, e-mail, Ruang GTK, Rumah Pendidikan, Manual	Medium	Flexible communication, reflective journaling, partial documentation, teacher journals, AI-powered government platforms
SMPN 10	School Website, WhatsApp, Manual Forms, Google Classroom, Ruang GTK, Rumah Pendidikan	Low	Limited digital infrastructure, early-stage digital culture, community-driven digital adoption, AI platforms as common foundation

Source: Based on observations, interviews, and documents, 2025

Note: All three schools consistently use government-supported platforms Ruang GTK and Rumah Pendidikan, which are integrated with Artificial Intelligence (AI) features supporting automated performance analysis, personalized learning recommendations, and streamlined administration.

Artificial Intelligence (AI) refers to the simulation of human intelligence in machines programmed to think, learn, and make decisions autonomously. In educational contexts, AI enables systems to analyze vast amounts of data, thereby enhancing decision-making and operational efficiency (Russell Stuart J & Norvig P, 2009). In the supervision process at SMP Negeri 1 Probolinggo, SMP Negeri 5 Probolinggo and SMP Negeri 10 Probolinggo, AI integration within platforms like Ruang GTK and Rumah Pendidikan plays a pivotal role. These platforms utilize AI for automated performance analysis, identifying patterns in teacher and student data that support targeted feedback and professional development. Furthermore, AI-driven personalized learning recommendations facilitate customized instructional strategies, aligned with each teacher's and student's unique needs (Bulut et al., 2024). Such automation also streamlines administrative tasks, freeing supervisors and teachers to focus more on reflective practice and innovation. This adoption aligns with the Society 5.0 paradigm, which envisions a human-centered society where AI, IoT, and digital technologies collaborate to solve social challenges while empowering human capabilities (Bhabajyoti Saikia, 2023) By leveraging AI within government-supported platforms, these school foster an adaptive, data-informed, and collaborative professional culture among aducators.

The varied implementation reflects the interplay between technological readiness, digital culture, and leadership. The success at SMP Negeri 5 Probolinggo supports findings by Bawaneh et al. (2024), who emphasized that electronic supervision improves teacher satisfaction and instructional supervision when infrastructure and supervisor capacity are in place. The collaborative use of digital tools facilities timely feedback, transparency, and continuous learning (Oehne C & Bardua S, 2019). Dai et al. (2023) also underscore that virtual supervision fosters teacher autonomy and reflective practices when web-based tools are strategically employed. At SMP Negeri 5 Probolinggo, integration of performance management systems like Ruang GTK aligns with performance planning, monitoring and feedback cycles identified in Pouliakas K (2021) and Suparman (2021) Conversely, SMP Negeri 10 Probolinggo reflects gaps identified by Mehdi et al. (2024) regarding low digital supervision efficacy due to training and device access limitations.

The transition to digital supervision requires more than just tools, it necessitates a paradigm shift toward digital leadership and ongoing capacity building Ichsan R N et al. (2023) Google Workspace, for example allows collaborative editing, centralized documentation, and real-time supervision, which enables more systematic editing, centralized documentation, and real-time supervision, which enables more systematic, accessible, and interactive supervision, especially at SMP Negeri 5 Probolinggo. Theoretically, the integration of technology in supervision aligns with the TPACK framework Koehler (2016), enabling the convergence of technological, pedagogical, and content knowledge within the supervision domain. Supervision, when enhanced through these tools, not only fosters more consistent professional feedback but also reinforces distributed leadership and learning accountability. Thus, digital supervision redefines performance management in schools, shifting from annual appraisal to continuous professional dialogue. In line with Armstrong (2004) and Anurogo et al. (2023), digital tools are not merely surveillance instruments but platforms for reflective growth, collaboration, and teacher empowerment, especially in the Society 5.0 era.

Adaptation of Supervision Practices Based on Teacher Context

Supervisory strategies are adapted based on teacher characteristics. Senior teachers in SMP Negeri Probolinggo are granted autonomy and peer-sharing roles. Novice teachers in SMP Negeri 5 Probolinggo receive structured and directive supervision. In SMP Negeri 10 Probolinggo, teachers with low digital proficiency are mentored gradually with blended approaches. Additionally, coaching-based supervision was identified in all three schools as an emerging approach, especially for supporting reflective practice, performance improvement, and confidence-building among teachers. Coaching clicnics, goal-setting sessions, and personalized feedback were used in various formats.

Table 2. Contextual Adjustment of Supervision Strategies

Teacher Group	Type of Supervision	Example School	Description
Senior Teachers	Reflective and collegial	SMPN 1	Granted autonomy and encouraged to share best practices
Novice Teachers	Directive and structured	SMPN 5	Step-by-step modeling and guidance
Digitally Literate	Digital-based supervision	SMPN 5	Tasks, feedback, and reporting are done online
Digitally Limited	Mixed/manual supervision	SMPN 10	Gradual transition with personal mentoring
All Groups	Coaching-based supervision	SMPN 1,5,10	Focused on personalized growth, reflection, and skill development through structured dialogue and feedback

Source: Based on observations, interviews, and supervision documents, 2025

The adaptive approach asserts that no single supervisory method fits all situations. Instead, supervisory strategies must be tailored to context, teacher needs, technological readiness, and school culture. Armstrong (2004) supports this view, highlighting the importance of supervisors' ability to read context and adjust their interventions accordingly. The effectiveness of coaching-based supervision is further evidenced by findings from SMP Negeri 10 Probolinggo, where coaching has transformed traditional evaluative supervision into more collaborative and empowering process. According to Agustyowati (2024) 85% of teachers reported improved confidence and teaching performance after receiving coaching from school leaders. Coaching contributed to better lesson planning, more interactive classroom management, and enhanced use of learning media. The principal's role as a learning facilitator enabled teachers to reflect, innovate, and improve their practices continuously. This aligns with (Glickman, C. D., Gordon, S. P., & Ross-Gordon, 2001) and Knight (2008) emphasis on coaching as a professional development tool that fosters reflective teaching and continuous improvement.

This study demonstrates flexibility in the choice of supervisory methods adapted to teacher profiles, whether novice or expert and in the use of online, offline, or blended coaching. This approach has proven effective in fostering authentic, adaptive, and sustainable teacher professionalism. The inclusion of coaching as part of hybrid supervision enhances teacher agency and aligns with adult learning principles, reinforcing collaborative inquiry and dialogic supervision (Milasari et al., 2021); Knowles, 1980).Furthermore, interview and observation data indicate that integrating both approaches fosters a strong collaborative climate among teachers, principals, and supervisors. Relationships built on mutual trust serve as the foundation for successful supervision, echoing Novebri & Lubis (2022), who emphasized that supervisory success depends on trust and shared goal orientation. In practice, supervisors act as learning facilitators rather than bureaucratic monitors. This shift reflects a transformation from administrative leadership to transformational leadership, promoting sustainable capacity building among teachers.

The implementation of clinical supervision, carried out in three stages: panning, implementation, and feedback was conducted effectively and has proven to enhance teacher professionalism (Yulia Jayanti Tanama et al., 2016). Clinical supervision helps teachers identify their strengths and weakness in the teaching process, enabling them to improve their instructional practices reflectively and collegially. The importance of an egalitarian relationship between teacher and supervisor is emphasized, making the "It Depends" approach (needs-based supervision) highly relevant. The technological leadership exhibited by school principals can yield positive outcomes on the digital professional capabilities of teachers. This is achieved by cultivating a digital culture among teachers through collaboration and communication (Rasdiana et al., 2024).Collaborative leadership strengthens educational community networks, encourages innovation, and enhances institutional reputation (Rahmawati & Supriyanto, 2020). Humanistic based active-collaborative supervision was very effective in order to improve teachers' professional

competence in carrying out their duties (Bambang Budi Wiyono & Ali Imron Kusmintardjo, 2015). This quote provides a foundation for the importance of collaborative and humanistic approaches as part of an adaptive and contextual supervision approach. The society 5.0 era demands educational transformation that not only leverages technology but also emphasizes humanistic values. Teachers are not just facilitators but innovators who navigate complex roles. Therefore, supervisory systems must respond to evolving teacher needs and dynamic learning contexts. This paradigm underscores the urgency of integrating digital supervision with adaptive approaches like "It Depends" to ensure flexible, context-responsive supervisory practices. This strategy supports Armstrong (2004) and Handayani & Baitaputra (2024), who emphasized context-responsive supervision as key to meaningful professional development. The "It Depends" approach enables supervisors to diagnose readiness levels and apply differentiated methods. It promotes reflective practice, personalized mentoring, and reduces resistance among less experienced or digitally challenged educators (Azhar et al., 2021; Muchlis & Putra P, 2022). Theoretically, integrating digital supervision with the "It Depends" approach shifts supervisory practices from pedagogical (control-based) to andragogical (collaborative and reflective) in line with Knowles' adult learning theory. Teachers are positioned as autonomous learners with experience and intrinsic motivation, while supervisors create spaces for dialogue and critical reflection, reinforcing distributed leadership in school quality management.

Formation of Professional Knowledge in Use (PKiU) through Digital and Adaptive Supervision

The research findings indicate that the integration of digital supervision with adaptive approaches significantly contributes to the formation of Professional Knowledge in Use across the three case study schools. PKiU which refers to the reflective and contextual application of professional knowledge in daily teaching practices M Eraut (2002), was found to be increasingly developed through collaborative supervision processes supported by digital technology. Here is the implementation of PKiU, supervisory mechanism, and their effects on teacher practices on the three school in Probolinggo Town:

Table 3. Implementation of PKiU, Supervisory Mechanisms, and Their Effects on teacher Practices in the Context of Society 5.0

School	Form of PKiU Evidence	Supervisory Mechanism	AI & IoT Integration	Impact on Teacher Practice	Illustrative Quote
SMPN 5	Lesson plan revisions based on e-feedback, digital teaching portfolios using Google Workspace	e-coaching sessions via Ruang GTK, collaborative tools (Website, Google Workspace), Ruang GTK, Rumah Pendidikan	Advanced AI features in Ruang GTK for performance analytics, IoT enabled real-time classroom data capture via digital devices	Increase confidence, experimentation with innovative strategies, and data-based instruction	*"I revised my teaching methods based on the feedback I received online, and we discussed it again in the coaching clinic. I became more confident in trying new approaches afterward."* – Teacher 1, SMPN 5.
SMPN 1	Reflective journals, collaborative lesson reviews digitally	WhatsApp group mentoring, coaching clinics, real-time feedback via shared Google Docs coaching clinics, Ruang GTK, Rumah Pendidikan	AI-powered feedback via government platforms, IoT supports digital communication and data sharing	Strengthened collegiality, enhanced self-reflection, and use of peer insights for instructional decisions	*"When we reflect together using shared documents, I feel like I learn not just from the supervisor, but also from other teachers' perspectives. It makes me rethink my classroom strategies."* – teacher 2, SMPN 1
SMPN 10	Contextual adaptation through peer mentoring	Informal peer coaching, gradual digital exposure, Ruang GTK, Rumah Pendidikan	Early-stage AI usage through government platforms, limited IoT infrastructure, emerging digital culture	Improved responsiveness to diverse student needs, stronger internal mentoring culture	*"Sometimes I directly ask senior teachers about how to handle difficult students. Their advice has become my go-to method."* – Teacher 5, SMPN 10

Source: Based on observations, interviews, and supervision documents, 2025

This table illustrates how hybrid supervisory approaches, integrating AI-enabled platforms, IoT-based communication, and human-cantered coaching, capture the collaborative spirit of Society 5.0. In this era, where data-

driven decision-making, adaptive efficiency, and ethically grounded leadership are crucial, these schools exemplify how supervision can evolve to nurture reflective, innovative, and professional educators at the forefront of digital transformation. The findings presented in table 3 highlight the role of hybrid supervision, which merges digital technologies with human-cantered mentoring in fostering PKiU across diverse educational context. This aligns with the Society 5.0 vison that advocates for seamless integration of AI, IoT, and digital platforms with human creativity and ethical leadership (Eslami & Patrizia Garengo, 2024). Such supervisory practices enable teachers to adapt responsively and innovatively to instructional challenges.

For example, SMP Negeri 5 Probolinggo leverages structured digital tools like Ruang GTK and Google Workspace, powered by AI analytics and IoT-enabled real-time data capture, to provide targeted feedback. This encourages teachers to revise lesson plans and experiment with innovative teaching strategies. This supports Paksuniemi et al. (2021) findings that digital supervision enhances teacher agency when combined with reflective coaching. On the other hand, SMP Negeri 1 Probolinggo focuses on collegial reflection via shared digital documents and informal WhatsApp mentoring groups, fostering a community of practice (Wiyono et al., 2021). This approach mirrors Society 5.0's human-centric principle, where technology augments rather than replaces collaborative decision-making and contextual adaptability (Ghosh, 2025). Meanwhile, SMP Negeri 10 Probolinggo shows that even with limited technological infrastructure, informal peer mentoring and gradual introduction of digital reflection tools empower teachers to develop responsive classroom strategies. This finding echo Fullan et al. (2014)argument that authentic pedagogical transformation emerges from socially embedded, practice-based learning. These differences indicate that effective hybrid supervision depends not only on technological readiness but also on leadership styles, school cultures, and deliberate integration of feedback mechanisms. Collectively, the supervisory models in this study contribute to an ethically grounded, technology-supported, and contextually adaptive educational ecosystem, core characteristics of supervisory practices essential in the Society 5.0 era.

The development of PKiU found in this study is consistent with Thiessen (2000), who emphasizes the importance of active, reflective, and contextual use of professional knowledge. The integration of adaptive and collaborative digital supervision enables teachers not only to receive evaluation but also to engage in continuous joint learning processes (Zamiri & Esmaeili, 2024a). Liu et al. (2024); Pea (2006) asserted that the use of digital technology in supervision such as video documentation and digital teaching archives, strengthens teacher reflection and promotes data-based instructional innovation. Moreover, the implementation of Professional Learning Communities (PLCs) supported by digital platforms fosters the collaborative and contextual construction of knowledge, as emphasized by (Liu et al., 2024). Furthermore, the results align with L. Herod (2002) principles of andragogy, which highlight that adult learners require learning approaches that are relevant to their experiences and provide space for self-reflection. Adaptive supervision supported by technology allows teachers to engaged in evidence-based decision-making more effectively and to build a dynamic professional identity (Price & Kirkwood, 2011). The transformation evident in the development of PKiU reinforces the nation that supervision is not merely an evaluative process but a contextual, collaborative, and adaptive professional learning process. This is highly relevant in the society 5.0 era, where digitalization and the demand for flexibility in learning call for more innovative and responsive supervisory approaches (George & Hovan George, 2024).

E-supervision for instruction is a supervisory framework that employs Information and Communication technology (ICT) as a support tool across all stages, from planning and implementation to evaluation. The objective is to elevate teacher professionalism, ensuring the seamless and efficient progression of the learning process (Rasdiana et al., 2024). This quote supports the use of digital approaches in supervision as a means to enhance teacher professional competence in the spirit of the 5.0 era. Through the supervision of education, coaching activities are carried out by a professional to assist teachers in improving teaching materials, methods, and evaluations, so that teachers become more professional in increasing the achievement of school goals (John A. Ross, 1992). This reinforces the role of supervision as a form of professional coaching that aligns with the effort to develop Professional Knowledge in Use. Additionally, the use of digital platforms enables more intensive and real-time interaction between supervisors and teachers, facilitating continuous monitoring and feedback. This aligns with the digital supervision model developed by Gorni et al. (2024), which emphasizes that combining technology with adaptive approaches can accelerate the professionalization of teachers in dynamic learning environments.

Contribution of Integrated Digital and Adaptive Supervision to Enhancing Teacher Professionalism in the Society 5.0 Era

The society 5.0 era presents both significant challenges and opportunities for teacher professional development. The advancement of digital technology must be balanced with an adaptive and contextual supervision approach so that teachers can transform into reflective, innovative, and responsive professionals. This study found

that the integration of digital supervision with the adaptive "It Depends" approach effectively strengthens three main dimensions of teacher professionalism: reflective competence, data-informed decision-making, and professional collaboration.

A. Enhancing Reflective Competence through Digital Feedback and Adaptive Interaction

The use of digital tools such as Website, Google workspace, Learning Management Systems (LMS), WhatsApp, and other collaborative applications allows for timely, objective, and well-documented feedback. This provides space for teachers to continuously reflect on their teaching practices. Melek Koc (2024) demonstrated that using LMS in supervision increased teachers' awareness of their strengths and weaknesses, fostering continuous improvement. Digital skills such as data literacy, information technology proficiency, and problem-solving abilities are key factors. The readiness of Human Resources to adopt advanced technologies and human-centric approaches in the Industrial revolution 4.0 and 5.0 era depends on their willingness to acquire new skills and adapt to rapid transformations (Dermawan et al., 2025). The adaptive "It depends" approach tailors' supervision according to the needs and characteristics of teachers, considering factors such as experience, readiness, and the learning context. This aligns with Elwood F. Holton et al. (2001) andragogy theory, which states that adult learning is most effective when it is contextually relevant and involves personal reflection. Ismail (2018) confirmed that supervision accommodating teachers' professional maturity positively impacts motivation and reflective competence development.

B. Facilitating Data-Informed Professional Decision-Making

Digital supervision not only facilitates communication but also systematically collects teacher performance data through online observations, recorded lessons, and student assessment result. This data is then analysed to provide concrete and measurable improvement recommendations. Alyssa Friend Wise (2018) found that the use of real-time data in supervision leads to more accurate pedagogical decision-making and improved learning quality. The adaptive approach ensure that the use of data aligns with teachers' abilities to interpret and apply supervision results. For example, novice teachers receive intensive, concrete guidance, while experienced teachers have space for independent analysis and pedagogical innovation. Robert J. Marzano (2011) emphasized that adaptive supervision is crucial to avoid failure in technology implementation due to mismatched individual teacher needs.

C. Promoting a Collaborative and Trust-Based professional Culture

Digital integration enables the formation of active professional networks beyond face-to-face meetings, strengthening a culture of collaborative learning and sharing of best practices. Digital platforms serve as a medium for reflective dialogue, mentoring, and intensive peer coaching. This is consistent with Kristin Warr Pedersen (2017) concept of communities of practice as the foundation for sustainable professional learning. Adaptive supervision, which prioritizes dialogue and teacher participation, builds trust and reduces resistance to change. Transformational leadership that directs supervision toward learning facilitation triggers innovation and increased teacher motivation. Meredith et al. (2023) found that a strong collaborative culture in digital supervision positively correlates with improved teacher performance and job satisfaction. There is a significant positive correlation between teachers' participation in the teacher Working group meeting and their professionalism. The most effective development technique is teaching demonstration (Hussain, 2020). This support the idea that contextual learning strategies, such as teaching demonstration, which can be facilitated digitally have an impact on the development of teacher professionalism.

D. Addressing Challenges and Leveraging Enabling factors

Despite the significant potential, challenges such as limited infrastructure and digital literacy remain barriers to optimal digital and adaptive supervision implementation. Ameli et al. (2024) revealed that without ongoing training and technical support, both teachers and supervisors struggle to maximize the use of supervision technology. School Leadership plays a crucial role in realizing teacher professionalism in the 5.0 era, where digital integration and adaptive technology implementation are essential to address diverse individual teacher needs. Transformational and visionary leadership fosters a culture of continuous innovation, supporting teachers through digital empowerment, personalized learning pathways, and collaborative professional development. Transformational leadership not only focuses on technological innovation, but also shapes adaptive and collaborative values through soft skills development, digital learning hubs, and multimodal literacy (Isam Zabalawi, 2024). Transformational leadership facilities the development of technology-based learning platforms, enabling students and teachers to engage in flexible, self-directed learning (Gebhardt & Matati Josua, 2025).

Digital supervision is not merely a monitoring tool, but also a means of empowering teachers to access and utilize adaptive learning platforms. Visionary and collaborative leadership have a central role in ensuring optimal resource management to support innovation, including digital publication and professional development (Fauzi Alfaruqi & Nizam Fahmi, 2025). Kubiczek (2024) suggest that an adaptive and visionary leadership approach is necessary for the sustainable development of digital and adaptive supervision. Furthermore, (Soslau, 2012)emphasize that the success of adaptive supervision also depends on the establishment of reward system that motivate teachers to innovate and develop professionally.

E. Implication for Enhancing Teacher Professionalism in the Society 5.0 Era

This integrated supervision approach answers the call for a new paradigm in educational supervision focused on facilitation, empowerment, and the professional development of teachers as change agents. Teachers in society 5.0 must combine digital skills with adaptive and reflective attitudes to navigate complex and diverse learning challenges. AI-powered platforms provide automated performance analysis and personalized learning recommendation, and AI enhances personalized professional development and efficiency in supervision (Ali et al., 2024). IoT enables real-time monitoring of teacher activities and integration of digital devices in classrooms and IoT supports adaptive, data-driven supervision aligning with Society 5.0 paradigm (Ojo et al., 2022). Digital supervision provides easy access, documentation, and effective interaction, while the adaptive approach ensures the supervision process is aligned with teachers' real needs, making it more humane and contextual. This combination produces teachers who are not only technically competent but also critically aware, pedagogically innovative, and highly collaborative.

Conclusion

This study demonstrate that the implementation of digital-based supervision can be effectively operationalized by adapting to the characteristics and context of each school, thereby enhancing a more structured and efficient supervisory process. The adaptive approach has proven capable of accommodating teacher's needs and school conditions contextually, making supervision more relevant and responsible to learning challenges. The integration of digital supervision and the adaptive approach significantly contributes to developing applicable professional knowledge, encouraging teachers to engage in critical reflection, innovative in teaching practices, and respond effectively to the dynamics of the society 5.0 era. Key enabling factors for the success of this hybrid supervisory model include technological readiness, strong leadership support, and a school culture that fosters innovation, while challenges such as varied digital literacy and limited infrastructure remain obstacles that need to be addressed. Overall, the integration of digital and adaptive supervision plays a crucial role in enhancing teacher's professionalism through human-technology collaboration, the utilization of AI and IoT, and data-driven decision-making, while upholding ethical leadership principles and sustainable development in the educational context of society 5.0.

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