

Transforming Pedagogical Innovation: The Interplay of ICT Utilization Effectiveness, Leadership, and Teacher Self-Efficacy

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Abstract

This study investigates the structural relationships among transformational leadership, ICT utilization effectiveness, and teacher self-efficacy in relation to teacher innovativeness, examines the mediating role of work motivation, and establishes operational improvement priorities using the SITOREM framework. Using a quantitative survey approach, data were collected from 153 civil servant (ASN) teachers across public senior high schools in West Bogor Regency via multistage random sampling. Data were analyzed sequentially using structural path analysis and SITOREM evaluation in SPSS 26. The findings indicate that all independent variables exert direct, positive, and significant effects on teacher innovativeness, with ICT effectiveness as the strongest predictor ($\beta = 0.425$), followed by transformational leadership ($\beta = 0.216$), work motivation ($\beta = 0.163$), and self-efficacy ($\beta = 0.156$). Work motivation significantly operates as a partial mediator across all structural pathways. SITOREM analysis prioritized the pedagogical suitability of ICT tools and teacher proactivity/initiative as the top operational indicators requiring immediate institutional improvement. This research contributes theoretically by advancing an integrative empirical model of teacher innovativeness and, practically, by bridging statistical path analysis and actionable management decision-making. However, the study is limited by its geographical focus on civil servant educators in West Bogor. Future research should expand sampling across broader regional contexts and incorporate variables such as school organizational culture, digital pedagogical competence, and data literacy.

Kata Kunci:

Efektivitas TIK; Efikasi
Diri Guru; Keinovatifan
Guru; Kepemimpinan
Transformasional;
Motivasi Kerja

Abstrak

Penelitian ini bertujuan untuk menganalisis hubungan struktural antara kepemimpinan transformasional, efektivitas pemanfaatan TIK, dan efikasi diri guru terhadap keinovatifan guru, dengan menguji peran mediasi motivasi kerja serta menetapkan prioritas perbaikan operasional melalui metode SITOREM. Menggunakan pendekatan survei kuantitatif, data dikumpulkan dari 153 guru ASN SMA Negeri di wilayah Bogor Barat melalui teknik *multistage random sampling*. Data dianalisis secara bertahap menggunakan analisis jalur dan evaluasi SITOREM dengan SPSS 26. Hasil penelitian menunjukkan bahwa seluruh variabel bebas berpengaruh langsung, positif, dan signifikan terhadap keinovatifan guru, dengan efektivitas TIK sebagai prediktor terkuat ($\beta=0,425$), diikuti oleh kepemimpinan transformasional ($\beta=0,216$), motivasi kerja ($\beta=0,163$), dan efikasi diri ($\beta=0,156$). Motivasi kerja terbukti berperan signifikan sebagai mediator parsial (*partial mediator*) pada seluruh jalur struktural. Analisis SITOREM memprioritaskan kesesuaian TIK dengan kebutuhan pedagogis serta inisiatif/proaktivitas guru sebagai indikator operasional utama yang memerlukan

perbaikan mendesak. Penelitian ini memberikan kontribusi teoretis dalam pengembangan pemodelan empiris keinovatifan guru serta kontribusi praktis dengan menjembatani analisis jalur statistik menuju pengambilan keputusan manajerial yang lebih konkret. Namun, penelitian ini memiliki keterbatasan dalam cakupan sampel guru ASN di Bogor Barat. Penelitian selanjutnya direkomendasikan untuk memperluas cakupan wilayah serta mengintegrasikan variabel budaya organisasi sekolah, kompetensi pedagogik digital, dan literasi data.

INTRODUCTION

Rapid digital transformation has fundamentally altered educational paradigms, imposing urgent demands on educators to demonstrate instructional innovativeness in designing adaptive, technology-enhanced, and future-oriented learning experiences. Teacher innovativeness is no longer understood merely as the generation of novel ideas, but as a dynamic capacity to synthesize digital technologies, pedagogical creativity, and contextual problem-solving within classroom practice (Todino, 2025; Zhazira et al., 2025). Empirical evidence demonstrates that systematically integrating digital tools fosters teachers' innovative competence, critical thinking, and instructional efficiency (Cai et al., 2024; Stambekova & Zhumabayeva, 2026). However, despite extensive national policy mandates and substantial capital investments in educational digitalization, a persistent gap remains between macro-level digital infrastructure availability and micro-level classroom adoption, particularly in public secondary education settings (Garzon & Inga, 2023; Kannan et al., 2026).

Many teachers continue to rely on traditional, passive teaching strategies, underscoring that infrastructure alone cannot guarantee pedagogical innovation unless supported by individual and organizational readiness. A critical determinant of instructional innovation is the operational effectiveness of Information and Communication Technology (ICT) utilization. Effective ICT integration enables teachers to construct interactive, learner-centered environments that broaden access to contemporary knowledge repositories (Sarzhanova et al., 2024; Xu & Chen, 2016). Nevertheless, technological effectiveness extends far beyond physical access to hardware and software; it requires technological pedagogical content knowledge (TPACK) to select tools aligned with specific pedagogical objectives (Almithqal & John, 2025). Recent findings indicate that while educators generally hold positive attitudes toward digital transformation, real-world execution is frequently constrained by limited technological fluency, inadequate contextual training, and misaligned instructional resources (Jupakkal, 2024; Kurebayeva et al., 2025).

Targeted professional development and continuous technical support are thus essential to convert basic ICT usage into meaningful, innovative teaching practices (Sanz et al., 2023). Beyond technological access, teacher innovativeness is driven by an interplay of internal psychological states and external organizational conditions. Anchored in Social Cognitive Theory and Transformational Leadership Theory, individual confidence and institutional support function as dual engines for pedagogical change. Teaching self-efficacy acts as an internal psychological engine, empowering teachers to risk adopting non-conventional pedagogical approaches and overcome technological anxieties (Bandura, 1978; Ding et al., 2026). Simultaneously, transformational leadership serves as an environmental catalyst, where visionary principals provide intellectual stimulation, individualized support, and an organizational climate conducive to experimentation (Al-Ayed, 2024; Zhukabayeva et al., 2025). These dimensions are further sustained by robust institutional governance and appraisal mechanisms that nourish work motivation and

psychological empowerment as primary driving forces for sustained innovative performance (Erdem & Koçyiğit, 2025; Fathima & Velayutham, 2026; Muneer et al., 2025).

Despite growing scholarship on teacher development, a major methodological and practical gap persists in the existing literature. Most empirical studies examine relationships among leadership, ICT, self-efficacy, motivation, and innovativeness through isolated bivariate correlations or conventional structural equation models (Al-Ayed, 2024; Muneer et al., 2025). While these quantitative models verify statistical significance (β path coefficients), they offer limited practical utility for educational managers because they fail to identify which specific operational indicators require immediate intervention and which require maintenance. Conventional path analysis explains what influences innovation, but leaves school leaders without an evidence-based roadmap for resource allocation. Combining Path Analysis with the Scientific Identification Theory to Conduct Operational Research in Education Management (SITOREM) addresses this gap by synthesizing path coefficients with empirical indicator scores to produce an actionable priority matrix for strategic management (Audi et al., 2026; Hidayat & Patras, 2024).

To address these empirical and methodological gaps, this study investigates the direct and indirect structural relationships among transformational leadership, ICT utilization effectiveness, teacher self-efficacy, work motivation, and teacher innovativeness, while applying SITOREM to prioritize strategic interventions in Indonesian public senior high schools. Specifically, this research examines how transformational leadership, ICT effectiveness, and teacher self-efficacy directly and indirectly influence teacher innovativeness; the extent to which work motivation mediates these structural relationships; and which specific operational indicators should be prioritized for immediate improvement or maintained under the SITOREM framework. By synthesizing structural path analysis with strategic indicator prioritization, this study contributes theoretically by advancing an integrative empirical model of teacher innovativeness and practically by providing education policy-makers with an evidence-based operational roadmap for sustainable teacher professional development.

METHODS

This study employed a quantitative research design utilizing an explanatory survey approach to examine causal and structural relationships among transformational leadership (X1), ICT utilization effectiveness (X2), teacher self-efficacy (X3), work motivation (X4), and teacher innovativeness (Y). The research was conducted across public senior high schools in Bogor Regency, West Java, spanning 14 sub-districts. The target population comprised 238 civil servant (ASN) teachers. To determine an adequate sample size, the Taro Yamane formula was applied with a 5% margin of error ($e = 0.05$), yielding a required minimum sample size of 153 teachers (Sugiyono, 2020; Yamane et al., 2017). Sampling was executed using a multistage random sampling technique to ensure proportional representation across geographic clusters (Creswell & Poth, 2018). In the first stage, public senior high schools were stratified based on sub-district location; in the second stage, ASN teachers from each school were randomly selected proportional to the total population of civil servant educators in each institutional unit (Sekaran & Bougie, 2016).

Table 1 Operationalization of Variables

Variable	Indicators	Scale	Theoretical Sources
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Transformational Leadership (X1)	Ideal impact, intellectual stimulation, management openness, inspirational motivation, personal support, autonomy & trust	5-point Likert (1–5)	Bass & Avolio (1994); Al-Ayed (2024)
Effectiveness of ICT Utilization (X2)	Suitability to needs, ease of use, information quality, accessibility, time efficiency	5-point Likert (1–5)	DeLone & McLean (2003); Xu & Chen (2016); Almithqal & John (2025)
Teacher Self-Efficacy (X3)	Initiative & proactivity, strength of conviction, resilience to failure, acceptance of plurality, self-regulation, context coverage	5-point Likert (1–5)	Bandura (1977 1997); Gerbino (2020); Ding et al (2026)
Work Motivation (X4)	Promotion, self-development, work performance, intrinsic interest, incentives, job satisfaction	5-point Likert (1–5)	Deci & Ryan (2000); Erdem & Koçyiğit (2025); Muneer et al (2025)
Teacher Innovativeness (Y)	Idea generation, pedagogical experimentation, contextual problem-solving, digital media adaptation	5-point Likert (1–5)	Scott & Bruce (1994); Pollock et al (2021); Stambekova & Zhumabayeva (2026)

Source: Data Collection, 2026

Data collection was operationalized through a self-administered, structured questionnaire designed on a 5-point Likert scale, ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). The administration process took place over four weeks, involving both direct physical distribution during school visits and monitored electronic submissions to maximize response rates and preserve respondent confidentiality. (Tabachnick & Fidell, 2018). Of the 170 distributed questionnaires, 153 were fully completed, yielding an effective response rate of 90%. To ensure psychometric robustness, instrument validation was conducted before field deployment through a pilot study involving 30 high school teachers who were not part of the study sample. Construct validity was tested using Pearson's Product-Moment correlation coefficient ($r_{count} > r_{table}$ at $\alpha = 0.05$). At the same time, internal consistency reliability was assessed using Cronbach's Alpha coefficient, adhering to the standard threshold criterion of $\alpha > 0.70$. All sub-indicators across the five study variables met the criteria for validity and reliability during instrument calibration.

Statistical data analysis was conducted sequentially using SPSS version 26. Parametric prerequisite tests were executed before structural modeling, including error normality tests using the Liliefors test, variance homogeneity tests using the Bartlett/Chi-Square test, and linearity tests using ANOVA ($F_{count} < F_{table}$, $p > 0.05$) (Tabachnick & Fidell, 2018). Structural relationships were evaluated via Path Analysis, which was decomposed into two substructures: Substructure 1 examined the direct influences of transformational leadership, ICT utilization effectiveness, teacher self-efficacy, and work motivation on teacher innovativeness, while Substructure 2 examined the direct influences of transformational leadership, ICT utilization effectiveness, and teacher self-efficacy on work motivation (Creswell, 2018). Indirect mediation hypotheses were verified using the Sobel test and Preacher and Hayes' indirect effect framework to calculate Z-score significance ($Z > 1.96$, $p < 0.05$). Finally, strategic priority allocation was determined using the SITOREM (Scientific Identification Theory to Conduct Operation Research in Education Management) method (Widodo, 2020).

RESULTS AND DISCUSSION

Results

Descriptive Statistics and Prerequisite Tests

Data were collected from N = 153 civil servants (ASNs) serving as senior high school teachers in West Bogor Regency. The descriptive statistics for all research variables are presented in Table 2.

Table 2. Summary of Statistical Description of Research Variables

Descriptive Parameter	Transformational Leadership (X1)	ICT Utilization Effectiveness (X2)	Teacher Self-Efficacy (X3)	Work Motivation (X4)	Teacher Innovativeness (Y)
Mean	142.83	140.25	139.97	130.98	136.93
Median	144.00	141.00	138.00	108.00	140.00
Std. Deviation	28.14	23.58	20.74	24.15	22.27
Minimum	61.00	72.00	69.00	80.00	87.00
Maximum	190.00	185.00	180.00	180.00	180.00
Theoretical Median	133.00	129.50	126.00	108.00	126.00

Source: Empirical data processed via SPSS 26.

A comparison of empirical median scores against theoretical medians reveals that Teacher Innovativeness (140.00 > 126.00), Transformational Leadership (144.00 > 133.00), ICT Utilization Effectiveness (141.00 > 129.50), and Teacher Self-Efficacy (138.00 > 126.00) fall into the high performance category. Work Motivation (108.00 = 108.00) aligns with the moderate category. Prerequisite parametric tests confirmed that standard errors of estimate were normally distributed via the Lilliefors test ($L\text{-count} < L\text{-table} = 0.060$, $\alpha = 0.05$). Bartlett's tests confirmed homogeneity of variance, and ANOVA linearity tests confirmed linear relationships across all structural pairs ($p > 0.05$).

Structural Path Analysis and Hypotheses Testing

Structural model evaluation was conducted by decomposing relationships into two sequential substructures and performing Sobel mediation tests.

Table 3. Substructure Path Coefficients and Direct Effects

Substructure / Path	Path Coefficient (β)	t-statistic	t-table	Sig. (p)	Decision
Substructure 1 (Dependent: Y)					
X1 → Y	0.216	3.774	1.652	0.000	Supported
X2 → Y	0.425	7.677	1.652	0.000	Supported
X3 → Y	0.156	2.850	1.652	0.005	Supported
X4 → Y	0.163	2.673	1.652	0.008	Supported
Model Fit: $R^2 = 0.420$; $F = 38.551$; $p = 0.000$					
Substructure 2 (Dependent: X4)					
X1 → X4	0.335	5.608	1.652	0.000	Supported
X2 → X4	0.221	3.673	1.652	0.000	Supported
X3 → X4	0.245	4.160	1.652	0.000	Supported
Model Fit: $R^2 = 0.270$; $F = 26.380$; $p = 0.000$					

Source: Primary data processed by authors using SPSS 26 (2026)

In Substructure 1, ICT utilization effectiveness (X2) exhibited the strongest direct positive effect on teacher innovativeness ($\beta = 0.425$, $p < 0.001$), followed by transformational leadership ($\beta = 0.216$, $p < 0.001$), work motivation ($\beta = 0.163$, $p = 0.008$), and teacher self-efficacy ($\beta = 0.156$, $p = 0.005$). Collectively, these variables accounted for 42.0% of the variance in teacher innovativeness ($R^2 = 0.420$, $F = 38.551$, $p < 0.001$). In Substructure 2, transformational leadership

exerted the largest direct effect on work motivation ($\beta = 0.335$, $p < 0.001$), followed by self-efficacy ($\beta = 0.245$, $p < 0.001$) and ICT effectiveness ($\beta = 0.221$, $p < 0.001$), explaining 27.0% of the variance ($R^2 = 0.270$, $F = 26.380$, $p < 0.001$).

Table 4. Indirect Effects and Sobel Mediation Test Results

Indirect Structural Path	Indirect Path Coeff.	Z-score	Sig. (p)	Mediation Type
X1 $\rightarrow$ X4 $\rightarrow$ Y	0.107	4.79	0.0005	Partial Mediation
X2 $\rightarrow$ X4 $\rightarrow$ Y	0.088	2.11	0.0005	Partial Mediation
X3 $\rightarrow$ X4 $\rightarrow$ Y	0.116	2.29	0.0001	Partial Mediation

Source: Calculated Sobel test results based on path coefficients (2026)

Indirect effect testing confirmed that work motivation (X4) significantly mediates the impacts of transformational leadership ($Z = 4.79$, $p < 0.001$), ICT effectiveness ($Z = 2.11$, $p < 0.001$), and self-efficacy ($Z = 2.29$, $p < 0.001$) on teacher innovativeness. Because all direct effects remained statistically significant, work motivation operates as a partial mediator across all structural pathways.

SITOREM Strategic Priority Matrix (RQ3)

By combining structural path coefficients (β) with indicator weightings evaluated across Cost, Benefit, Urgency, and Importance (CBUI) criteria, SITOREM analysis yielded a prioritized action matrix.

Table 5. SITOREM Strategic Decision Priority Matrix

Variables (Priority)	Indicators Need Improvement (Priority 1-5)	Indicators Maintained
Effectiveness of ICT ($\beta=0.425$, Priority I)	1. Suitability to needs (18.29%) 2. Ease of use: maintained 3. Information quality (17.07%) 4. Accessibility (15.85%) 5. Time efficiency (15.85%)	Ease of use (17.07%)
Transformational Leadership ($\beta=0.216$, Priority II)	1. Intellectual stimulation (13.22%) 2. Management openness (11.57%) 3. Inspirational motivation (11.57%) 4. Personal support (11.57%) 5. Autonomy & trust (10.74%)	Ideal impact (10.74%)
Work Motivation ($\beta=0.163$, Priority III)	1. Promotion (23.19%) 2. Self-development (17.39%) 3. Work performance (16.67%)	Interest (20.29%); Incentives (20.29%); Satisfaction (18.84%)
Self-Efficacy ($\beta=0.156$, Priority IV)	1. Initiative & proactivity (19.05%) 2. Strength of conviction (17.86%) 3. Resilience to failure (16.67%) 4. Acceptance of plurality (16.67%) 5. Self-regulation (15.48%)	Field/Context coverage (14.29%)

Source: Synthesized Empirical Indicator Scores and CBUI Expert Panel Weightings, 2026

SITOREM results indicate that intervention programs must prioritize strengthening ICT suitability to pedagogical needs (18.29%) and principal intellectual stimulation (13.22%), while maintaining baseline competencies such as ease of ICT use (17.07%) and leadership ideal impact (10.74%).

DISCUSSION

The empirical findings of this study establish that the effectiveness of ICT use is the strongest direct driver of teacher innovativeness. When educators effectively integrate digital technologies into instructional design, their capacity to construct interactive learning environments, experiment with creative methodologies, and adapt digital media expands substantially. This outcome strongly reinforces empirical conclusions positioning digital literacy and effective technology application as essential catalysts for instructional transformation (Todino, 2025; Xu & Chen, 2016). Furthermore, these findings align directly with recent large-scale quantitative investigations demonstrating that systematic engagement with digital tools directly enhances teachers' innovative competence, critical thinking, and pedagogical flexibility (Stambekova & Zhumabayeva, 2026; Zhazira et al., 2025). Effective ICT utilization provides the technical foundation that enables teachers to move beyond passive lecturing toward active, student-centered learning practices.

However, a deeper critical synthesis through the SITOREM framework reveals a vital operational nuance regarding technology integration. While teachers demonstrate high baseline technical fluency in operating basic digital tools, the primary operational bottleneck lies in aligning ICT resources with specific pedagogical needs and curricular objectives. Technological adoption often fails to produce meaningful classroom innovation when educators lack technological pedagogical content knowledge (Almithqal & John, 2025; Jupakkal, 2024). Without precise pedagogical alignment, digital infrastructure investments risk remaining superficial and underutilized. This distinction supports established theoretical insights emphasizing that sustainable educational digitalization requires shifting professional development programs from generic software instruction toward subject-specific, context-aware digital integration (Delone & McLean, 2003; Kannan et al., 2026; Sarzhanova et al., 2024).

From a psychological perspective, teacher self-efficacy serves as the internal cognitive foundation that sustains instructional innovation. Grounded in Social Cognitive Theory, an educator's conviction in their professional capabilities directly dictates their cognitive engagement, perseverance through instructional obstacles, and willingness to undertake pedagogical risks (Bandura, 1978; Gerbino, 2020; Tekin, 2023). In educational environments characterized by rapid digital flux, self-efficacy acts as a protective psychological mechanism that mitigates technology-induced anxiety and encourages creative experimentation. This finding directly reinforces the dual-pathway framework, demonstrating that self-efficacy operates as a crucial resource-enabling channel that promotes innovative work behavior in academic institutions (Ding et al., 2026). When teachers believe in their teaching competence, they view technological disruptions as opportunities for professional growth rather than intimidating threats.

Nevertheless, the SITOREM analysis highlights a critical vulnerability in teacher agency that requires targeted intervention. Despite possessing adequate domain expertise, teachers exhibit a pronounced operational weakness in taking independent initiative and demonstrating proactivity when introducing novel instructional strategies. This empirical finding echoes broader concerns that traditional teacher preparation systems frequently foster passive compliance rather than proactive innovation (Kurebayeva et al., 2025; Sanz et al., 2023). Educators often hesitate to depart from standardized instructional scripts due to fear of failure or a lack of institutional backing. Cultivating sustainable teacher innovativeness therefore necessitates institutional structures that actively build psychological safety, provide structured peer coaching, and encourage risk-tolerant pedagogical experimentation (Bandura, 1978; Ding et al., 2026).

At the organizational level, the structural model demonstrates that transformational leadership is a vital environmental trigger for instructional change. School principals who provide intellectual stimulation, foster administrative openness, and communicate an inspiring vision create a supportive climate where teachers feel empowered to challenge conventional instructional routines (Al-Ayed, 2024; Bass & Avolio, 1990). Visionary leadership reduces administrative friction and legitimizes creative experimentation within the school culture. Digital transformation in educational institutions cannot succeed through technological acquisition alone; it requires empathetic, transformational leadership that aligns institutional goals with teacher development (Zhukabayeva et al., 2025). Principals who actively support digital initiatives build organizational trust, thereby motivating teachers to step out of their comfortable instructional routines and embrace innovative teaching practices.

Furthermore, the mediation analysis confirms that work motivation operates as a significant partial mediator across all structural pathways. This partial mediation mechanism yields a crucial theoretical insight: while work motivation enriches and energizes innovative performance, it does not function as an absolute gatekeeper for instructional change (Erdem & Koçyiğit, 2025). Teachers equipped with high self-efficacy and effective ICT tools can initiate instructional innovations even when external motivational incentives are suboptimal. Individual technological competence and psychological self-belief can directly bypass organizational inertia (Fathima & Velayutham, 2026; Muneer et al., 2025). Nevertheless, establishing transparent merit-based promotion systems and funded self-development pathways remains essential for preventing burnout and ensuring long-term institutional sustainability (Breuer et al., 2023; Erdem & Koçyiğit, 2025).

The primary theoretical and practical contribution of this study lies in bridging structural path analysis with actionable management decision-making via the SITOREM framework. Standard empirical literature routinely stops at presenting statistical coefficients, leaving educational leaders without clear guidance on how to prioritize institutional resources (Garzon & Inga, 2023; Rahman et al., 2026). By synthesizing structural weights with empirical indicator scores, this study provides an evidence-based operational hierarchy for educational management. Educational authorities in Bogor Regency are directed to focus immediate resources on strengthening the pedagogical fit of digital technologies, upgrading information quality, and enhancing infrastructure accessibility (Almithqal & John, 2025; Cai et al., 2024). Concurrently, leadership programs must expand principals' capacity for intellectual stimulation, while appraisal systems are overhauled to reward innovative teaching transparently (Serdyukov, 2021; Stambekova & Zhukabayeva, 2026; Zhukabayeva et al., 2025). This prioritized strategy offers a sustainable roadmap for advancing teacher innovativeness.

Table 6. Synthesis of Empirical Findings, Theoretical Coupling, and Actionable SITOREM Roadmap

Core Findings & Priority Level	Theoretical Alignment	Literature Comparison	Actionable Management Roadmap
ICT Effectiveness (Priority I)	Technological Pedagogical Content Knowledge (TPACK);	Aligns with Xu & Chen (2016) and Stambekova & Zhumabayeva (2026);	Shift ICT training from basic software usage toward subject-specific pedagogical integration and accessibility enhancement.
Primary direct predictor of teacher innovativeness	DeLone & McLean Model	Extends Almithqal & John (2025)	

Transformational Leadership (Priority II) Primary environmental trigger for motivation & innovation	Transformational Leadership Theory (Bass & Avolio, 1994)	Supports (2024) Zhukabayeva et al. (2025)	Al-Ayed and	Develop principal capacities for intellectual stimulation and administrative openness to grant teacher pedagogical autonomy.
Work Motivation (Priority III) Functions as a partial mediator across structural paths	Self-Determination Theory (Deci & Ryan, 2000)	Corroborates (2025) and Fathima Velayutham (2026)	Erdem &	Overhaul performance appraisal systems to provide clear merit-based promotion and funded self-development pathways.
Teacher Self-Efficacy (Priority IV) Internal cognitive foundation for taking pedagogical risks	Social Cognitive Theory (Bandura, 1977, 1997)	Reinforces (2020) and Ding et al. (2026)	Gerbino	Build professional learning communities (PLCs) and peer coaching to encourage risk-tolerant instructional experimentation.

Source: Data Collection, 2026

CONCLUSION

This study confirms that the effectiveness of ICT utilization, transformational leadership, work motivation, and teacher self-efficacy is a structural driver of teacher innovativeness in public senior high schools. Structural path analysis indicates that ICT utilization effectiveness exerts the strongest direct positive influence on teacher innovativeness ($\beta = 0.425$), followed by transformational leadership ($\beta = 0.216$), work motivation ($\beta = 0.163$), and self-efficacy ($\beta = 0.156$), with all variables demonstrating direct, positive, and statistically significant relationships. Furthermore, work motivation serves as a significant partial mediator, indicating that technological effectiveness and individual self-belief can directly foster pedagogical innovation and are further energized by motivational mechanisms. Synthesizing these structural path coefficients with SITOREM analysis reveals a clear operational hierarchy, establishing that the appropriateness of ICT tools to pedagogical needs and teacher initiative and proactivity in self-efficacy must be prioritized for immediate improvement. In contrast, baseline competencies such as idea generation and courage to experiment must be maintained.

Theoretically, this study contributes to the educational management literature by bridging structural path modeling and operational research, offering a replicable framework that translates statistical coefficients into prioritized management decisions. In practice, these findings provide school principals and regional education offices with an evidence-based roadmap for designing contextualized, subject-specific ICT training programs and integrating self-efficacy-strengthening modules into professional development initiatives. Nevertheless, this research is subject to limitations, as its sampling scope was restricted to civil servant teachers across public high schools in West Bogor Regency and omitted broader organizational dynamics. To build upon these findings, future research should expand geographic sampling across diverse educational sectors and incorporate additional structural variables, such as school organizational culture, digital

pedagogical competence, and data literacy, to foster a more comprehensive model of teacher innovativeness in the digital era.

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