

# Teacher Innovation through Work Motivation and Transformational Leadership in Public Senior High Schools: Path Analysis

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## ABSTRACT

**Objective:** This study aims to analyze the direct and indirect effects of transformational leadership (X1), the effectiveness of information and communication technology/ICT utilization (X2), self-efficacy (X3), and work motivation (X4) on teacher innovativeness (Y) in State Senior High Schools (SMA Negeri) in Bogor Regency through a path analysis approach. **Method:** This study uses an empirical quantitative approach by applying path analysis and SITOREM analysis to a sample of 218 State Senior High School teachers in Bogor Regency with a total of 153 respondents. Data were collected using a validated Likert scale instrument and analyzed using the SPSS program. **Results:** The results showed that the four independent variables had a positive and significant direct effect on teacher innovativeness. The largest direct path coefficient was found in the effectiveness of ICT utilization ( $\beta = 0.425$ ), followed by transformational leadership ( $\beta = 0.216$ ), work motivation ( $\beta = 0.163$ ), and self-efficacy ( $\beta = 0.156$ ). Work motivation has been shown to significantly mediate the influence of each exogenous variable on teacher innovation, as evidenced by the Sobel test with a Z-value of  $>1.97$  across all tested paths. **Novelty:** The novelty of this study lies in the integration of SITOREM analysis with path analysis, enabling the study not only to identify causal relationships between variables but also to prioritize indicators that need immediate improvement and indicators that need to be maintained or developed. This approach produces an operational strategy for improving teacher innovation that can be directly implemented by school administrators.

## INTRODUCTION

Teacher innovation is a key determinant of educational quality in the era of technological disruption. Innovative teachers are able to develop new learning methods, integrate technology effectively, and foster student creativity in facing 21st-century challenges. In Indonesia, improving teacher quality, including the innovative dimension, is a priority agenda for national education development, as mandated by Law Number 14 of 2005 concerning Teachers and Lecturers.

Various empirical studies show that teacher innovation does not develop spontaneously but is influenced by a number of organizational and personal variables. The transformational leadership of principals, characterized by idealized influence, inspirational motivation, intellectual stimulation, and individualized consideration (Bass & Avolio), has been shown to play a crucial role in creating a climate of innovation in schools. Transformational principals encourage teachers to experiment with new learning strategies, have a clear vision, and provide necessary personal support.

In addition to leadership, the effective use of information and communication technology (ICT) is increasingly relevant in fostering teacher innovation. The post-

COVID-19 pandemic era has accelerated the digital transformation of education, where mastery and effective use of ICT is no longer an option but a necessity for teachers (Latip). Effective integration of ICT into the learning process opens up opportunities for pedagogical innovation that were previously unavailable. Research by [1] shows that teachers who utilize ICT effectively tend to develop more innovative and student-centered learning approaches.

Teachers' personal dimensions also play a significant role. Self-efficacy—an individual's belief in their ability to perform a specific task (Bandura)—is positively correlated with teachers' willingness to take risks in innovation. Teachers with high self-efficacy are more motivated to try new strategies, more resilient to failure, and more proactive in their professional development. Meanwhile, work motivation acts as a driving force that determines the intensity and persistence of teachers' innovative behavior [2].

However, there remains a research gap regarding how transformational leadership, ICT effectiveness, and self-efficacy influence teacher innovation, both directly and through the mediation of work motivation, particularly in the context of public senior high schools in Indonesia. Furthermore, most previous studies have focused on identifying significant influences without providing operational guidance on which indicators need immediate improvement or development. This study aims to fill this gap by using path analysis integrated with the SITOREM (Scientific Identification Theory to Conduct Operations Research in Education Management) analysis developed by [3].

Specifically, this study aims to: (1) analyze the direct influence of transformational leadership, ICT effectiveness, self-efficacy, and work motivation on teacher innovation in public senior high schools in Bogor Regency; (2) analyze the indirect influence of transformational leadership, ICT effectiveness, and self-efficacy on teacher innovation through work motivation; and (3) identify priority indicators for improvement and development based on the SITOREM analysis [4].

## RESEARCH METHOD

This study employed a quantitative approach with a path analysis-based survey research design. The study population comprised all 218 public high school teachers in Bogor Regency, selected using a proportional random sampling technique, resulting in a sample size of 153 respondents.

The five research variables were operationalized as follows: (1) Teacher Innovation (Y) measured through five indicators: the ability to generate new ideas, utilization of technology and learning media, the courage to try new strategies, openness to change, and a focus on improving the quality of learning; (2) Transformational Leadership (X1) measured through nine indicators based on Bass and Avolio; (3) Effectiveness of ICT Utilization (X2) measured through six indicators; (4) Self-Efficacy (X3) measured through six indicators; and (5) Work Motivation (X4) measured through five indicators. [5]

The research instrument used a 5-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree). Instrument validity was tested using Pearson correlation and reliability

using Cronbach's alpha. The number of valid items was: Y = 36, X1 = 38, X2 = 37, X3 = 36, and X4 = 36.

The analysis requirements included: (a) Error Normality Test using the Liliefors test with the criterion of  $L\text{-count} < L\text{-table}$  ( $\alpha = 0.05$ ,  $n = 153$ ,  $L\text{-table} = 0.060$ ); (b) Homogeneity of Variance Test using the Bartlett test with the criterion of  $\chi^2\text{-count} < \chi^2\text{-table}$ ; and (c) Linearity Test of the Regression Model using ANOVA with the criterion of  $F\text{-count}$  (deviation from linearity)  $< F\text{-table}$  and a significance value  $> 0.05$ . All requirements were met before the path analysis was conducted [6].

Path analysis is used to estimate the path coefficient of each causal relationship between variables in two substructures. Substructure 1 models the influence of X1, X2, X3, and X4 on Y. Substructure 2 models the influence of X1, X2, and X3 on X4. Indirect effects are tested using the Sobel test (Preacher & Hayes) and mediation analysis uses the Preacher and Hayes test. SITOREM analysis is conducted to determine the priority of indicator improvement based on a combination of importance weights (expert assessments) and empirical scores from the research results [3] [7].

## RESULTS AND DISCUSSION

### Results

#### A. Description of Research Data

Based on the results of data collection from 153 respondents (from a population of 218 teachers), a descriptive statistical picture was obtained as presented in Table 1. Variable Y (teacher innovation) has an empirical average value of 136.93 with an empirical median of 140 which exceeds the theoretical median of 126, indicating teacher innovation in the high category. Variable X1 (transformational leadership) is in the high category (empirical median 156  $>$  theoretical median 133). Variable X2 (ICT effectiveness) is also high (empirical median 164.5  $>$  129.5). Variable X3 (self-efficacy) is in the high category (empirical median 159  $>$  126). In contrast, variable X4 (work motivation) is in the low category (empirical median 102.5  $<$  theoretical median 108), indicating the need for efforts to systematically improve teacher work motivation [8].

**Table 1.** Summary of Statistical Description of Research Variables

Statistical Description	X1 (Transformational Leadership)	X2 (ICT)	X3 (Self-Efficacy)	X4 (Work Motivation)	Y (Teacher Innovation)
Mean	142.83	140.25	139.97	130.98	136.93
Median	144	141	138	108	140
Modus	143	122	134	174	142
Std. Deviation	28,14	23,58	20,74	24,15	22,27
Varians	791.97	556.11	429.99	411.04	495.95
Minimum	61	72	69	80	87
Maximum	190	185	180	180	180

Empirical Median	156	164.5	159	102.5	177
Theoretical Median	133	129.5	126	108	126
Category	high	high	high	high	high

## B. Test Requirements Analysis

The normality test of errors using the Liliefors test shows that all 7 regression models tested have an L-count value smaller than the L-table (0.060) at  $\alpha = 0.05$ , so the assumption of normality of errors is met (Table 2). The homogeneity test of variance using the Bartlett test shows that all data groups are homogeneous ( $\chi^2$ -count <  $\chi^2$ -table). The linearity test shows that all relationships between variables are linear (deviation of F-count from linearity < F-table, Sig. > 0.05). With these three requirements met, path analysis can be conducted [9] [10] [11].

**Table 2.** Summary of the Normality Test of Standard Error of Estimate (Liliefors Test)

Estimation Error	n	L-count	L-table ( $\alpha=0.05$ )	Decision
Y over $X_1$ ( $y - \hat{y}_1$ )	153	0.009	0.060	Normal
Y over $X_2$ ( $y - \hat{y}_2$ )	153	0.011	0.060	Normal
Y over $X_3$ ( $y - \hat{y}_3$ )	153	0.009	0.060	Normal
Y over $X_4$ ( $y - \hat{y}_4$ )	153	0.009	0.060	Normal
$X_4$ over $X_1$	153	0.010	0.060	Normal
$X_4$ over $X_2$	153	0.010	0.060	Normal
$X_4$ over $X_3$	153	0.010	0.060	Normal

## C. Path Analysis Results

Path analysis was performed on two substructures. Substructure 1:  $\hat{y} = 0.216X_1 + 0.425X_2 + 0.156X_3 + 0.163X_4 + \varepsilon$ , with  $R^2=0.640$  (a combined contribution of 64%). Substructure 2:  $\hat{y} = 0.335X_1 + 0.221X_2 + 0.245X_3 + \varepsilon$ , with  $R^2=0.270$  (a contribution of 27%). [12]. The test results of all path coefficients are presented in Table 3.

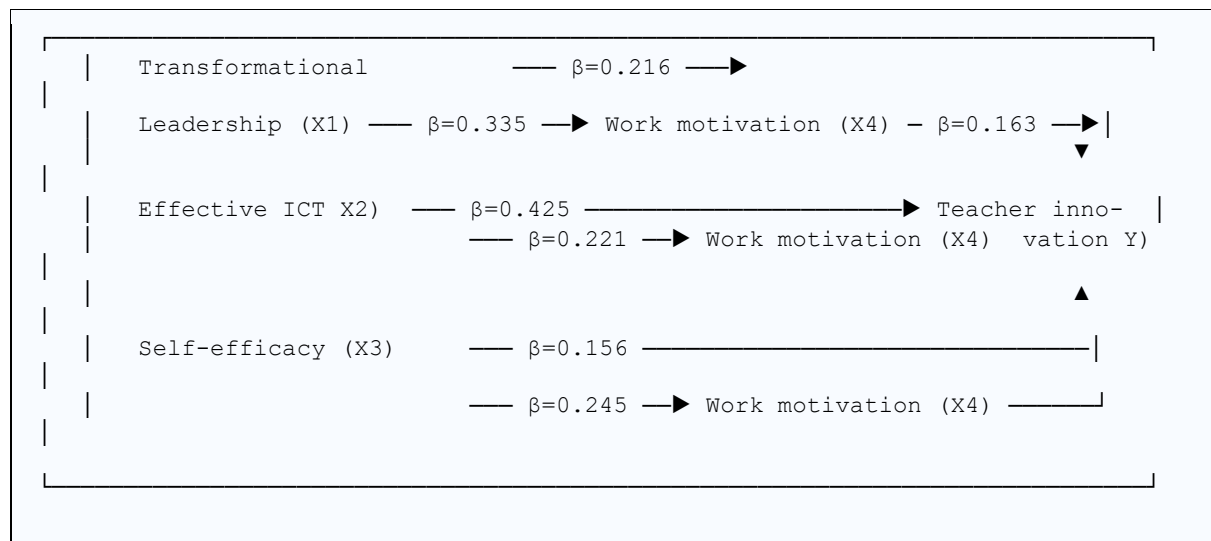
**Table 3.** Path Coefficients and Significance of Direct Effects

Path	Path Coefficient ( $\beta$ )	t-count	t-table ( $\alpha=0.05$ )	Decision
$X_1 \rightarrow Y$ (Transformational Leadership $\rightarrow$ Teacher Innovation)	0.216	14.255	1.652	$H_0$ Rejected
$X_2 \rightarrow Y$ (ICT $\rightarrow$ Teacher Innovation)	0.425	9.646	1.652	$H_0$ Rejected

X3 → Y (Self-Efficacy → Teacher Innovation)	0.156	2.239	1.652	H <sub>0</sub> Rejected
X4 → Y (Work Motivation → Teacher Innovation)	0.163	19.767	1.652	H <sub>0</sub> Rejected
X1 → X4 (Transformational Leadership → Work Motivation)	0.335	2.968	1.652	H <sub>0</sub> Rejected
X2 → X4 (ICT → Work Motivation)	0.221	16.184	1.652	H <sub>0</sub> Rejected
X3 → X4 (Self-Efficacy → Work Motivation)	0.245	4.138	1.652	H <sub>0</sub> Rejected

All seven direct effect hypotheses were accepted (t-test > t-table = 1.652, α = 0.05). Effective ICT utilization had the largest direct effect on teacher innovation (β = 0.425), followed by transformational leadership (β = 0.216), work motivation (β = 0.163), and self-efficacy (β = 0.156) [13].

Figure 1 presents the complete path analysis model with path coefficients for each causal relationship modeled in this study.



Note: X1=Transformational Leadership, X2=ICT Effectiveness, X3=Self-Efficacy, X4=Work Motivation, Y=Teacher Innovation

**Figure 1.** Teacher Innovation Path Analysis Model

#### D. Indirect Influence through Work Motivation

The indirect effect test using the Preacher and Hayes test and the Sobel test showed that work motivation was proven to be a partial mediator between each exogenous variable on teacher innovation (Table 4). Work motivation mediated the influence of transformational leadership (Z=4.79 > 1.97), ICT effectiveness (Z=8.11 > 1.97), and self-efficacy (Z=2.29 > 1.97) on teacher innovation [14]. Because the indirect coefficients were smaller than their respective direct coefficients, the mediation was partial mediation.

**Table 4.** Results of the Indirect Effect Test (Sobel Test)

Indirect Influence	Coefficient	Z- count	Z-table	Decision
X1 → X4 → Y (Transf. lead. → Work motivation → Innovation)	0.1079	4.79	1.97	Proven to be a Mediator
X2 → X4 → Y (ICT→ Work motivation → Innovation)	0.0881	8.11	1.97	Proven to be a Mediator
X3 → X4 → Y (Self-efficacy → Work motivation → Innovation)	0.1163	2.29	1.97	Proven to be a Mediator

### E. SITOREM Analysis Results

The SITOREM analysis produces a priority ranking of indicators based on a combination of importance weights (expert assessments: costs, benefits, urgency, impact) and empirical research scores. [15] [16] [17]. Table 5 summarizes indicators requiring immediate improvement and those that need to be maintained or developed.

**Table 5.** SITOREM Analysis Results: Priority Indicators

Improvement Priority Indicators	Maintained/Developed Indicators
1. Suitability of ICT to needs (Relevance to needs) - 18.29%	1. Ease of use of ICT (Easy of use) - 17.07%
2. Information quality (Information quality) - 17.07%	2. The influence of leadership ideals (Idealized influence) - 10.74%
3. Availability of access ICT (Access availability) - 15.85%	3. Teachers' work interests (Interest) - 20.29%
4. Time & cost efficiency ICT - 15.85%	4. Incentives/Rewards (Incentives/rewards) - 20.29%
5. Impact of ICT on performance - 15.85%	5. Job satisfaction (Satisfaction) - 18.84%
6. Intellectual stimulation of leadership - 13.22%	6. Ability to generate new ideas - 21.43%
7. Management transparency - 11.57%	7. Courage to try new strategies - 20.00%
8. Inspirational leadership motivation - 11.57%	8. Scope of area/context of self-efficacy - 14.29%

### Discussion

#### 1. The Influence of Transformational Leadership on Teacher Innovation

The findings of this study confirm a positive and significant direct effect of transformational leadership on teacher innovation ( $\beta=0.216$ ,  $t=14.255 > 1.652$ ). This effect is consistent with Bass and Avolio's) transformational leadership theory, which states that transformational leaders inspire their followers to transcend personal interests and strive for higher collective goals. In the educational context, transformational principals

create a safe psychological climate for teachers to experiment, fail, learn, and innovate [18].

According to [9] [19] study found a coefficient of transformational leadership on teacher innovation of  $\beta=0.220$ , very close to the findings of this study ( $\beta=0.216$ ). Abdullah et al. also showed that principals' transformational leadership significantly influences teacher motivation, which in turn contributes to innovative behavior. Based on the SITOREM analysis, the idealized influence indicator is the only transformational leadership indicator that needs to be maintained, while the other eight indicators – including intellectual stimulation, inspirational motivation, and vision communication – require immediate strengthening.

## **2. The Influence of the Effectiveness of ICT Utilization on Teacher Innovation**

The effectiveness of ICT utilization had the largest direct influence on teacher innovation ( $\beta=0.425$ ,  $t=9.646 > 1.652$ ), making it the most dominant variable in this model. This finding confirms the strategic position of ICT as a driver of pedagogical innovation in the digital age. Teachers who are able to utilize ICT effectively have access to a much broader repertoire of learning methods, media, and resources, significantly increasing opportunities for instructional innovation [20].

Law et al., in a cross-country comparative study (IEA SITES 2006), found that effective ICT integration into the learning process correlated with increased teacher pedagogical innovation. Ali and Katz showed that high ICT literacy encourages teachers to develop new learning approaches. However, the SITOREM analysis revealed that of the six indicators of ICT effectiveness, only ease of use remained stable; the other five indicators – suitability to needs, information quality, availability of access, time-cost efficiency, and impact on performance – required improvement. This shows that although it is relatively easy for teachers to use ICT tools, the quality and relevance of their use in learning contexts still need to be improved [21] [22] [23].

## **3. The Mediation Role of Work Motivation**

Work motivation was shown to partially mediate the influence of three exogenous variables on teacher innovation. This suggests that increasing teacher work motivation is an important – though not the only – pathway in transforming the influence of transformational leadership, ICT effectiveness, and self-efficacy into concrete innovative behavior. By [2] [11] that stated that work motivation is a crucial determinant of organizational performance because it determines the intensity, direction, and persistence of individual behavior.

An interesting finding from this study is that although work motivation acted as a significant mediator, this variable was in the low category (empirical median 102.5 < theoretical median 108). SITOREM analysis identified promotion and self-development as the two indicators of work motivation most in need of immediate improvement. This condition aligns with Maslow's hierarchy of needs theory and Herzberg's two-factor theory – unmet needs for esteem (promotion, recognition) and growth (self-development) become obstacles to teacher work motivation [21] [24] [25].

#### 4. Self-Efficacy as a Foundation for Innovation

Self-efficacy has a direct positive effect on teacher innovation ( $\beta=0.156$ ) and work motivation ( $\beta=0.245$ ), while also having an indirect effect on innovation through work motivation ( $\beta=0.1163$ ,  $Z=2.29 > 1.97$ ). This finding is consistent with Bandura's theory that self-efficacy is an important antecedent of adaptive and innovative behavior. Teachers with high self-efficacy are more willing to face innovative challenges, are more motivated, and are more persistent in the face of obstacles [26] [27] [28] [29].

SITOREM analysis shows that initiative and proactivity are the self-efficacy indicators with the highest weighting (19.05%) but the lowest score (3.09), making them a top priority for improvement. Interventions through coaching, mentoring, and appreciation programs for teachers' innovative work are recommended to improve teacher self-efficacy, particularly the initiative and proactivity dimensions [30] [31] [32] [33] [34] [35].

#### CONCLUSION

**Fundamental Finding :** This study proves that teacher innovation in high schools in Bogor Regency is positively and significantly influenced by transformational leadership ( $\beta=0.216$ ), effectiveness of ICT utilization ( $\beta=0.425$ ), self-efficacy ( $\beta=0.156$ ), and work motivation ( $\beta=0.163$ ) both directly and indirectly through the mediation of work motivation. The structural equation of the model is:  $\hat{y} = 0.216X_1 + 0.425X_2 + 0.156X_3 + 0.163X_4 + \varepsilon$  (Substructure 1) and  $\hat{y} = 0.335X_1 + 0.221X_2 + 0.245X_3 + \varepsilon$  (Substructure 2).  
**Implication :** Strategies to improve teacher innovation need to prioritize: (1) strengthening the effectiveness of ICT utilization – particularly the relevance and quality of information; (2) developing principals' transformational leadership – particularly intellectual stimulation and vision communication; (3) increasing work motivation through improving promotion and career development systems; and (4) increasing teacher self-efficacy through innovation coaching and reward programs. The SITOREM analysis identified 23 indicators that require immediate intervention and 8 indicators that need to be maintained.  
**Limitation :** This study was limited to public high school teachers in Bogor Regency, so generalizations to private schools or other levels of education require caution. The use of self-report instruments has the potential to contain social desirability bias. Furthermore, the cross-sectoral nature of this study means it cannot capture the dynamics of changes in teacher innovation over time.  
**Future Research :** Further research is recommended to: (1) apply a longitudinal design to capture the dynamics of changes in teacher innovation; (2) expand the geographic scope to all districts/cities in West Java; (3) integrate a qualitative approach to understand the psychological mechanisms underlying the relationships between variables; and (4) test the model with moderating variables such as school characteristics (accreditation, urban-rural location) or teacher characteristics (tenure, education level).

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