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The Role of Leadership, Work Environment, and Innovation in Enhancing Teacher Performance: A Structural Equation Modeling Approach

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ABSTRACT

This study analyzes how leadership, work environment, and innovation affect teacher effectiveness. These characteristics are increasingly important, but empirical evidence on their interrelationships is scarce, especially in environments with large teacher populations. The major goal was to test a structural model hypothesizing direct and indirect effects among these factors to fill quantitative teacher efficacy gaps. PLS-SEM via SmartPLS version 3.2.9 was used for quantitative analysis. To reach 0.95 power (medium effect size, α=0.05) from a population of 8,968, a minimum sample size of 218 respondents was established using G*Power. An online Google Forms questionnaire measured leadership (transformational and dynamic styles), work environment (supporting and ethical features), innovation (creative practices), and teacher performance (efficiency and outcomes) from 218 instructors. AVE, rho, and Cronbach's alpha (>0.70) validated instruments. The study evaluated measurement model reliability and validity, as well as structural model assessment (path coefficients, R^2, f^2, Q^2). Results validated four of five hypotheses. Innovation has a significant impact on teacher performance (β=0.613, $p<0.001$, f^2=0.645 large), along with leadership (β=0.498, $p<0.001$, f^2=0.282 small) and work environment (β=0.227, $p=0.003$, f^2=0.079 small). However, work environment did not significantly affect teacher performance (β=0.071, $p=0.290$, unsupported). The model explains 44.3% of variance in innovation (R^2=0.443, weak) and 67.6% in teacher performance (R^2=0.676, moderate), with medium predictive relevance (Q^2=0.247 for innovation, medium; Q^2=0.329 for teacher These findings support previous studies that transformative leadership and innovation promote success, whereas work environment is insignificant. To improve teacher results, educational leaders should promote innovation and leadership training. The study shows mediated paths (e.g., leadership via creativity) to improve PLS-SEM applications in education. Cross-sectional design and self-report bias are limitations; longterm studies could examine organizational culture factors.

Keywords: leadership, interest, motivation, learning outcomes

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INTRODUCTION

Bass (1985) Transformational leadership involves the ability to inspire, motivate, and influence people to perform beyond expectations, form a strong organizational culture, and create a shared vision that guides positive change. Northouse (2021) Leadership is about understanding and applying various theories and practices in appropriate contexts. Leadership is both an art and a science, which requires a deep understanding of oneself, others, and situations. Yukl (2012) Leadership in complex situations requires the ability to adapt, make informed decisions, and motivate people to achieve common goals, regardless of challenges. Avolio & Gardner (2005) Authentic leadership is about recognizing personal and moral values, and then integrating them into leadership roles. This creates the basis for positive and sustainable leadership development. Bennis & Nanus (1985) Effective leaders have the ability to identify appropriate strategies, take necessary steps, and take control in diverse situations. They also possess traits such as vision, integrity, and communication skills.

Chesbrough (2003) Open innovation expands the scope of a firm's innovation potential by utilizing external resources and collaborating with external partners. This changes the traditional paradigm of innovation and becomes a must for companies looking to create and utilize technology. Christensen (1997) Large companies often fail to adopt technological innovations because they focus too much on maintaining existing business models. This presents a dilemma for companies, where they must determine how to integrate new technological innovations without compromising existing business models. Tushman &; O'Reilly (1996) Ambidextrous organizations are those capable of running evolutionary innovation (incremental improvement) and revolutionary innovation (drastic change) simultaneously. They create a balance between exploration and exploitation, allowing them to adapt quickly in a changing environment. Dosi (1988) Innovation comes from multiple sources, involves a variety of processes, and has a significant impact on microeconomics. It is important to understand the role of sources, procedures, and microeconomic effects in describing the dynamics of innovation. Rogers (2003) The diffusion theory of innovation explains how innovation is propagated through societies and organizations. Innovation diffusion involves the process of communication, adoption, and adaptation of innovation by individuals and groups, and understanding the factors influencing this process is key to managing innovation successfully.

Hackman & Oldham (1976) Motivation through job design posits that well-designed work, which provides adequate task variety, autonomy, and feedback, can improve employee motivation and performance. Jobs that blend challenges with individual skills can create a fulfilling and motivating experience. Parker & Ohly (2008) An expanded framework for designing work that motivates nailing elements such as meaningful tasks, identification with work, task variability, autonomy, feedback, and roles in teams. Linking these job characteristics to motivation can help organizations design more fulfilling jobs. Cohen & Spector (2001) Fairness in organizations is an important factor in influencing employee motivation and behavior. Meta-analysis studies show that perceptions of fairness in organizational processes and outcomes are closely related to job satisfaction and organizational commitment. Kosse &; Ozeki (1999). A review of the literature shows that work-family policies can help address the gap between work and family, and affect employee productivity. Companies that pay attention to the need for balance between work and family can improve employee performance. Wagner & Scott (2014) Emotional labor in the workplace can have a negative impact on employees' personal lives. Emphasizing the emotional management necessary in the workplace can affect the well-being and family interactions of employees outside of working hours.

Hattie & Timperley (2007) The influence of feedback in educational contexts is strong and positive. Effective feedback can assist students and teachers in achieving better learning outcomes. This suggests that feedback serves not only as an evaluation, but also as a powerful learning tool. Marzano (2007). Effective teaching requires a comprehensive approach, covering various aspects such as lesson planning, teacher-student interaction, feedback, and evaluation. Understanding the art and science of teaching helps teachers in improving the quality of student learning. Ingersoll &; Strong (2011) Induction and mentoring programs for beginning teachers have a significant impact on teacher development and retention. This shows the importance of support and guidance for new teachers in facing their initial challenges in the education profession. Darling (2017). Looking at teacher education practices around the world can provide valuable insights into how to improve teacher education. Some international practices can be adapted and adopted to improve education systems in a variety of contexts. Guskey (2002). Professional development of teachers is an important component in the change and improvement of teaching practice. Teachers who engage in relevant and ongoing professional development are likely to experience positive changes in the way they teach

LITERATURE REVIEW

Suweko and Dwiantoro (2020) discuss transformational leadership in the context of increasing nurses' job satisfaction. They found that transformational leadership can positively impact nurses' job satisfaction. This research shows the importance of the role of leaders in shaping a positive work environment and motivating nurses. Purwanto et al. (2020) conducted a literature review on leadership models in educational institutions. They summarize the various leadership models that have been studied in an educational context. The results of this study can be an important reference for leaders in educational institutions to develop effective leadership strategies. Jamrizal (2022) examines the influence of planning, organizing, and supervising the leadership of school principals in the context of education management. This research highlights the relationship between management aspects and the leadership qualities of school principals. The results can provide insight for education practitioners in improving leadership in educational institutions.

Kristiawan et.al (2018) discusses the concept of educational innovation in East Java. In this study, the authors might explore different aspects of innovation in an educational context, although details of specific findings or contributions cannot be explained without access to the original text. Haryanto (2007) provides an educational perspective related to learning innovation. This article likely discusses the concept of innovation in the context of the learning process and perhaps evaluates its impact. More information is needed to provide a more detailed review. Rusdiana's research (2014) reviews the concept of educational innovation in general. Although there is no further information, this article may provide a conceptual basis for a further understanding of innovation in an educational context.

Hasibuan (2018) examines the influence of leadership, work environment, and work motivation on performance. This research highlights the role of the work environment in influencing employee performance. Hasibuan found that a conducive work environment can contribute positively to employee performance. Sofyan (2013) explained the influence of the work environment on the work performance of employees at Bappeda. This research

focuses on the relationship between the work environment and employee performance in the institution. The results of Sofyan's research can provide insight into how working environment conditions can affect employee performance Panjaitan (2018) examined the influence of the work environment on employee work productivity. This research highlights the importance of a supportive work environment in increasing employee productivity. Panjaitan points out that changes in the work environment can have a significant impact on employee productivity.

Pianda (2018) investigates teacher performance with a focus on teacher competence, work motivation, and principal leadership. The study revealed a link between these factors and teacher performance. Pianda found that strong teacher competence, high work motivation, and effective principal leadership can positively affect teacher performance. Lailatussaadah (2015) discusses efforts to improve teacher performance. The research highlights steps that can be taken to improve teacher performance. Lailatussaadah provides insight into the importance of training, support, and motivation in improving teacher performance. Octavia (2019) explores the attitudes and performance of professional teachers. This research highlights the importance of teachers' attitudes in influencing their performance. Octavia points out that teachers who have a good professional attitude tend to perform better.

H1: Is there any influence of leadership (X1) on teacher performance (Y)

H2:Is there an influence on the work environment (X2) is there teacher performance (Y)

H3: Is there any effect of innovation (X3) on teacher performance (Y)

H4: Is there any influence of leadership (X1) on innovation (X3)

H5: Is there any influence of the work environment (X2) on innovation (X3)

METHOD

This research uses a quantitative approach as its research methodology. Kusumastuti et al. 2020) quantitative research method is a scientific approach that utilizes quantitative data collection to understand and explain phenomena. This research emphasizes the use of measurement instruments that can produce data in the form of numbers, which are then analyzed statistically to identify significant

patterns, relationships, or trends. Quantitative research methods are often used to test hypotheses and provide generalizations to larger populations. Unaradjan (2019) quantitative research method is a scientific approach that utilizes quantitative data collection to analyze and explain the phenomenon under study. In this study, researchers used measurement instruments that produce data in the form of numbers, which are then analyzed statistically. Quantitative methods allow researchers to identify patterns, relationships, or trends in data and generalize to larger populations. Nurlan (2019) quantitative research method is a scientific approach that relies on quantitative data collection to analyze research phenomena. In this context, research is carried out using measurement instruments that produce data in the form of numbers, which are then analyzed statistically. Quantitative research methods allow researchers to identify patterns, relationships, or trends in data and generalize to a larger population.

The use of questionnaires or questionnaires is one of the commonly used instruments in research. These instruments enable researchers to collect data effectively and efficiently from respondents. As a data collection technique, questionnaires allow researchers to measure certain variables and gain an understanding of respondents' perceptions regarding the research topic. Using questionnaires, researchers can collect large amounts of data and obtain representative information from the intended population. Pujihastuti (2010) questionnaire in the context of research is an instrument designed to collect data from respondents through a series of written questions. This instrument plays an important role in obtaining quantitative information from research participants, and the writing of questionnaires must adhere to established principles to ensure the validity and reliability of the data obtained.

This research method used in this study is SEM PLS (Structural Equation Modelling Partial Least Squares) This method is used to test and analyze causal relationships between independent and dependent variables. To collect data, questioners were distributed and collected via google from to 218 redpondents. The collected data is then analyzed using several statistical methods. First, the reliability

of the data was measured using Cronbach alpha. Descriptive statistics such as mean and standard deviation are used to analyze the variables studied. The Pearson product-moment correlation coefficient is used to evaluate the relationship between variables. The t-test is used to test for differences in moderation variables. In addition, PLS-SEM (Partial Least Squares Structural Equation Modeling) is used to analyze significantly influential factors. In determining the sample size, researchers use the G Power App to analyze the required sample strength.

To measure the strength of the analysis in this study, G Power was used to determine a sufficient sample size. The total sample collected was 218 respondents, and with an analysis strength of 0.95 from a total population of 8,968. Data analysis was carried out using the SEM-PLS (*Partial Least Squares Structural Equation Modeling*) method using Smart PLS software version 3.2.9 according to a predetermined procedure. The first step is to test the measurement model to test the reliability and validity of the construct used. The second step is to conduct an assessment on a structural model that examines the direct relationship between exogenous (independent variable) and endogenous (dependent variable) variables (Hair, Hollingsworth, RandolpIh, &; Chong, 2017).

Table 1 G Power Analysis Results to determine total sample

	Input	Output	
Tails(s)	One	Noncentrality parameter δ	3.3015148
Effect size f^2	0,05	Critical t	1.6520729
α err prob	0,05	Df	212
Power (1-β err prob)	0,95	Total sample size	218
Number of predictors	5	Actual power	0.9501283

INSTRUMENTS

The instruments in this study are arranged in two parts. The first part is collecting demographic information of respondents, while the second part consists of 25 questions that include 4 constructs taken from the study. Akbari &; Maleki (2017) which contains 5 questions from 1 construct. Ashraf & Jalil (2020) which

contains 5 questions from 1 kontsruk. Acker (2020) which contains 5 questions from 1 construct. Campbell, J., & Kyriakides (2018) which contains 10 questions from 3 kontsruk. The constructs include leadership with 5 items, innovation with 5 items, work environment with 5 items, and teacher performance with 10 items. To ensure institutional adoption and facilitate research, each item was measured using a Likert scale with options of "never", "sometimes", "rarely", "often", and "always". All questionnaires were received by the respondents involved in this study.

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RESULT

RESEARCH RESULTS

Description of Research Data

Table 2 Demographic Profile of participants

Variable	Demographics	Frequency	Percentage	Mean
Gender	Woman	141	63,8%	
	Legal Law	80	36,2%	
Education Level	SD	63	28,5%	
	SMP	63	28,5%	
	SMA	95	43%	

Data Analysis

Table 3 Description of Questionnaire Statistics, loading factor, VIF, AVE, Composite reliability dan Cronbach's

Variable	Question	Mean	Loading	Bright	Bird	Reliability	Cronbach's

Leadership	• The leader provides clear and structured direction to the teacher. • Leaders encourage teachers' active participation in decision-making. • Leaders motivate teachers to achieve set goals. • Leaders encourage continuous teacher training and self-development. • Leaders provide sufficient support and resources to support teacher performance.	4.341 4.309 4.377 4.209 4.195	0.759 0.779 0.747 0.755 0.799	1.667 1.698 1.605 1.688 1.842	0.590	0.878	0.826
Innovation	• How often teachers adopt innovations in learning activities. • How effective are the innovations used in improving the quality of teacher learning? • How often teachers use innovative methods in teaching. • How much improvement in the quality of learning is achieved after implementing innovation. • How much impact innovation has on teacher motivation in teaching.	4.191 4.350 4.268 4.214 4.327	0.792 0.760 0.775 0.782 0.713	1.753 1.625 1.680 1.773 1.500	0.585	0.876	0.822
Work Environment	• A conducive work environment can increase teacher work motivation. • Adequate facilities in the work environment have a positive impact on teacher performance. • Good relationships between colleagues can improve teacher performance. • The availability of adequate resources helps improve teacher performance. • The support provided by superiors can affect teacher performance.	4.445 4.459 4.400 4.391 4.377	0.730 0.757 0.668 0.720 0.731	1.487 1.515 1.457 1.536 1.344	0.521	0.845	0.772
Teacher Performance	• How often you are given the opportunity to participate in training or professional development.	4.159 4.150	0.692 0.684	1.997 1.682	0.507	0.878	0.849

	• The extent to which you feel the support provided by the leadership at the school. • How often do you feel you have sufficient time for lesson preparation and planning? • How often school policies support innovation and experimentation in teaching. • How often do you feel support from colleagues in carrying out teaching duties. • How often do you feel high energy and passion in your job as a teacher? • How often do you receive constructive feedback from students about your teaching methods?	4.259 4.255 4.218 4.355 4.027	0.704 0.718 0.685 0.723 0.774	1.616 1.740 1.637 1.482 1.708			

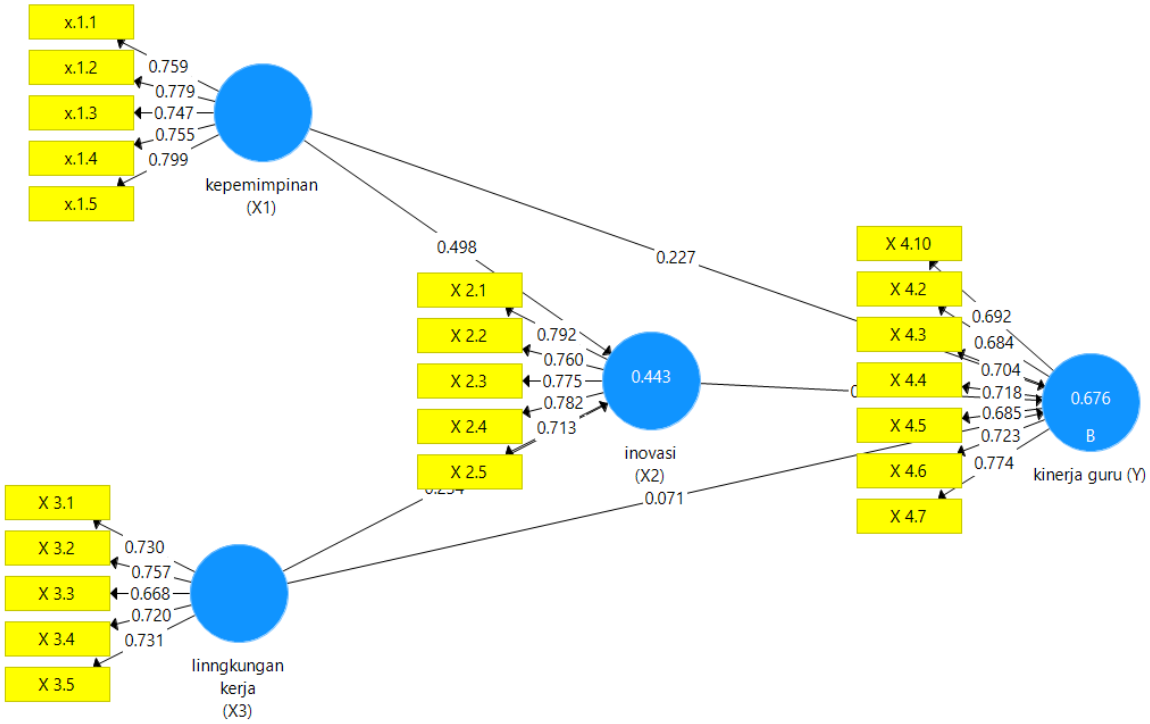

Figure 1: Results of PLS Management Algorithm

Evaluasi Model Pengukuran Confirmatory Composite Analysis (CCA)

Step 1: Evaluate the loading speed of the indicator and its relevance. To be significant in a two-tailed test at a rate of 5%, standardized loads must have a value

of at least 0.708 and related t-statistics must be above ± 1.96 (Hair, Ringle, & Sarstedt, 2011). T-statistics PLS-SEM is obtained through bootstrapping procedures (Hair, et al., 2012). In contrast, Wood (2005) introduced confidence intervals for PLS-SEM. Confidence interval loading indicators can be used in a similar way to t-statistics and intervals that do not include zero are statistically significant. The confidence interval has the advantage that a dichotomous significance testing approach does not need to be used, and authors may consider alternative methods to find practically significant indicator loading when using confidence intervals (Cohen, 1994). We generate data using SmartPLS 3.2.9 to display the loading of all items. Table 3 and Figure 1 comprehensively summarize the loading of the 22 items. Work environment (LK3; 0.668) has the lowest score, while leadership has the highest value (K5; 0.799).

Step 2: The load square of an individual indicator can be used to calculate the number of variances shared between an individual indicator variable and the construct associated with it. This is referred to as a measure of reliability. (Hair, *et al.*, 2019).

Step 3: There are two ways to measure construct reliability: Cronbach alpha (α) and composite reliability (CR). The rule of thumb for both of these reliability criteria is that it should be above 0.70. Composite reliability, which has weights, is more accurate than Cronbach alpha because indicators do not have the same reliability. Therefore, CR must be assessed and reported (Hair et al., 2019). Keep in mind that the reliability of internal consistencies, such as the reliability of composites and Cronbach alpha, can be too high. Individual items measure the same concept if the reliability is 0.95 or higher. In other words, redundancy indicates that the indicators measure the same concept and therefore do not include the diversity necessary to ensure multi-item constructs are valid (Hair et al., 2019). In table 3 related *cronbach alpha* and *composite reliability* values show values above 0.70 and all constructs have good values. Where in leadership Cronbach's value and Reliability is 0.826 &; 0.878. And for innovation, Cronbach's value and Reliability are 0.822 &; 0.876. Cronbach's value and reliability in the work environment is

0.772 & 0.845. Finally, on the teacher performance variable, Cronbach's value and Reliability were 0.849 &; 0.878.

Step 4: The extent to which indicators used to measure the same variable correlate with each other and have similarities in measuring the same construct is referred to as convergent validity. The AVE value is a convergent validity metric used to measure the proportion of variance described by a structure and reflects the average reliability of its indicators. The AVE value is generally 0.5 or higher, which means if the AVE value of a variable is 0.5 or more, then the variable is considered convergent validity. In this study in Table 3, it is explained that the variable "kineja guru" has an AVE value of 0.507, which explains 50% of the variation, while the variable "leadership" has the highest AVE value of 0.590, which represents 59% of the variation. The AVE values in both examples exceed the 0.5 criterion limit, indicating that both variables have sufficient convergent validity. Therefore, based on the AVE values you provide, it can be said that the convergent validity of the variables in your study supports the predictions made. To obtain more accurate convergent validity, it is important to conduct proper statistical analysis and consider the context of the study thoroughly. However, it should be noted that the explanations given above are based on the information you provide and do not involve complete statistical analysis.

Step 5: When the variant shared in a construct (AVE) is greater than the variant shared between constructs, that construct is considered valid. *The heterotrait-monotrait ratio of correlations* (HTMT) is the method that should be used (Henseler, Ringle, & Sarstedt, 2015). To better understand HTMT ratio and discriminant validity, researchers can use cutting scores such as 0.85 and 0.90. In addition, Franke and Sarstedt (2019) recommend additional significance testing that includes confidence intervals. All HTMT values in Table 5 get values less than 0.900, indicating a significant difference. In Smart PLS 3.2.9 applications, discriminant validity was tested using *cross-loading, Fornell-Larcker Criterion* and *Heterotrait-Monotrait (HTMT) methods* (Henseler *et al.,* 2015).

Table 4 *Fornell-Larscher* Criterion

	Innovation	Leadership	Teacher Performance	Work Environment
Innovation	0,765			
Leadership	0,639	0,768		
Teacher performance	0,796	0,662	0,712	
Work Environment	0,534	0,604	0,536	0,722

Table 4 above is used to evaluate the validity of discriminants according to the Fornell-Larcker criteria and cross-loading. In this table, values outside the diagonal indicate the relationship between each variable, while diagonal values are the square of the mean values indicating the average variation extracted (AVE) of each variable which is higher compared to the other variables. Thus, it can be concluded that the AVE root value has a value greater than the relationship between the variables below it. In this case, the mean square value of each variable is higher than the value of the relationship between variables with other variables to be tested, indicating that the form has good discriminant validity (Hair, *et al.*, 2011). Therefore, the results of discriminant validity testing conducted in this study using the *Heterotrait-Monotrait Ratio* technique can be found in the following table 5.

Table 5 Rasio *Heterotrait-Monotrait (HTMT)*

	Innovation	Leadership	Teacher Performance	Work Environment
Innovation				
Leadership	0,775			
Teacher Performance	0,942	0,758		
Work Environment	0,660	0,745	0,605	

Experts argue that the Fornell-Larcker criterion and cross-loading method are less sensitive in assessing the validity of discriminants. Therefore, to evaluate the validity of the discriminant, a heterotrait-monotraite ratio (HTMT) is recommended. The HTMT method looks at the relationship between different constructions and indicators within the same construction. The expected HTMT

value must be less than 0.9 in order to indicate the validity of the discriminant between the two reflective variables. If the HTMT value between the two reflective variables is lower than 0.9 as the data results in table 5, it can be concluded that the research instrument used has adequate discriminant validity. In the variables of leadership, teacher performance, and work environment towards innovation have values of 0.775, 0.942, 0.660. For the variables of teacher performance and work environment on leadership are values of 0.758 and 0.745. Finally, the work environment on teacher performance is valued at 0.605. However, it is important to note that the assessment of discriminant validity does not rely solely on a single method, such as HTMT, but is best combined with other approaches, such as *cross-loading and* the Fornell-Larcker *criterion*, as well as other contextual considerations. Therefore, to ensure discriminant validity thoroughly, it is recommended to use several methods of measuring discriminant validity and analyze the results comprehensively taking into account the relevant research context.

Structural Model Evaluation or Structural Model Assessment

Step 1: The basic concepts and features of multiple regression analysis are essential for the evaluation of structural model results. Therefore, the first step is to examine the construct of the structural model to find out if high multicollinearity is a problem. Structural models with high multicollinearity can affect the size of the beta coefficient by increasing or decreasing the value as well as changing the sign of the same coefficient. The value of VIF can be seen like a formative construct indicator; If the value is below 3.0, then multicollinearity may not matter. An alternative method is to assess bivariate correlations between construct scores. The size and/or mark of the path coefficient can be affected by multicollinearity if the bivariate correlation is greater than 0.50. The suggested solution when multicollinearity appears to be a problem is to combine separate constructs into theoretically similar and supportive lower-level constructs (Cenfetelli & Bassellier, 2009). The Variance Inflation (VIF) factor was used to measure collinearity in this study. The VIF values in the data analysis are presented in Table 3, which shows that

there are no VIF values above 5.0, which indicates that there is no multicollinearity problem in this study (Hair et al., 2017).

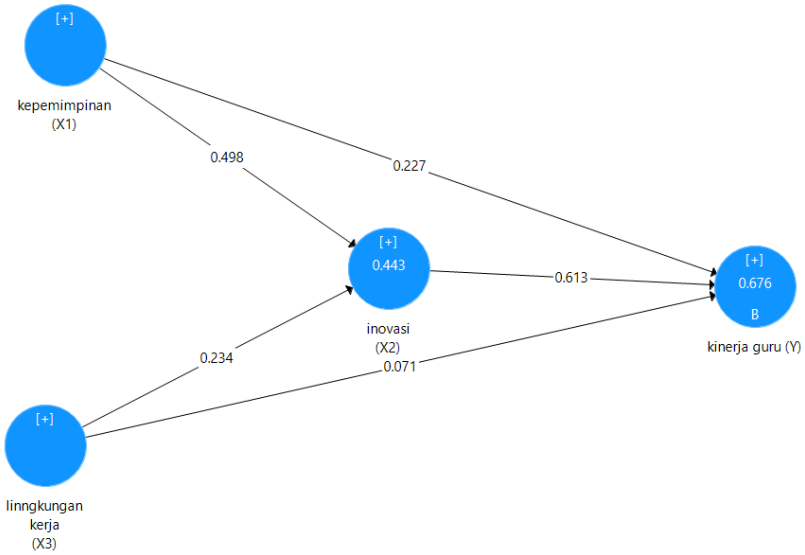

Figure 2 : Bootsraping Processing Results

Step 2: The second step is to check the size and significance of the path coefficient if multicollinearity is not an issue. With this method, researchers can examine the alleged relationship between these constructs. The path coefficient is a standardized value that can range from +1 to −1, but rarely approaches +1 or -1. This is especially true for complex models that have many independent constructs in the structural model. The closer the path coefficient value is to zero, the less its ability to predict dependent (endogenous) constructs and the stronger its ability to predict dependent constructs. From the figure presented above, there is a hypothetical model that describes the partial influence of each research variable, including leadership, innovation, work environment, and teacher performance. To evaluate the structural model, the research data was subjected to bootstrapping method (500 sub-samples). The structural model for these seven research hypotheses proved significant with p values on the innovation hypothesis →teacher performance of 0.000, on the leadership →innovation hypothesis of 0.000, the leadership hypothesis →teacher performance of 0.003, the next hypothesis of work

environment →innovation of 0.006, the work environment →teacher performance of 0.290 (Table 6)

Table 6 Summary of Hypothesis Test Results

H	Hipotesis	Koesifien Line	P values	
H1	Innovation → Teacher Performance	0.613	0.000	Supported
H2	Leadership →Innovation	0.498	0.000	Supported
H3	Leadership → Teacher Performance	0.227	0.003	Supported
H4	Work Environment → Innovation	0.234	0.006	Supported
H5	Work Environment → Teacher Performance	0.071	0.290	Not Supported

Step 3: R2, referred to as the coefficient of determination and is a predictive measure in a sample of all endogenous constructs, is the metric most often used to assess the predictions of structural models, as in multiple regression models. This means that prediction is a measure of predictive ability only for the sample of data used to calculate the outcome, and R2 cannot be inferred to the population (Rigdon, 2012; Sarstedt et al. 2014). The minimum R2 value is 0, but rarely there are lower values. The value of R2 increases with the number of independent variables (constructs) in the structural model, as shown by multiple regression, assuming that those independent variables are actually related to the constructs of the dependent variables. The highest R2 value is 1, but it is rare. To evaluate the R2 size of the structural model, researchers should review similar relevant empirical research and use these findings as guidelines, assuming the context of the study is not too different. Lastly, a number of fields investigate adjusted R2; it systematically changes the R2 value down based on the sample size and number of prediction constructs. Adjusted R2, as in multiple regression, is useful when researchers include too many insignificant predictor constructs in structural models (Hair, *et al.*,

2017). For example, if the R2 values are 0.75, 0.50, and 0.25, then the model shows strong, medium, and weak levels of strength in explaining endogenous variables (Sarstedt, et al., 2017). In research conducted by Hair et al. (2020), R2 values are 0.67, 0.33, and 0.19. These values are generally considered to be strong, medium, and weak levels of strength. Table 7 below shows the measurements made in this study using the coefficient of determination (R2). The data in Table 7 shows that teacher performance has a moderate determination test, while innovation has a weak determination test. Thus, based on the measurement results in this study, teacher performance variables have a moderate level of strength in explaining their variability, while innovation variables have a weak level of strength in explaining their variability.

Table 7 Coefficient of Determination (R2)

	R Square	R Square Adjusted
Innovation	0.443	0.438
Teacher Performance	0.676	0.671

Step 4: The effect size is the second measure for the predictive ability of the structural model. This measure estimates the predictive ability of each independent construct in the model. To calculate this value, SmartPLS automatically removes any predictor constructs from the model, and a new R2 is calculated without those predictors. Furthermore, the value of R2 with the predictor in the model is different from the value of R2 without the predictor. This difference in R2 values indicates whether the omitted construct is a significant predictor of the dependent construct (Hair et al., 2017). The effect factor f2 is categorized into small, medium, and large. Values greater than 0.02 to 0.15 are considered to have little effect; values between 0.15 and 0.35 are considered to be moderately influential; and a value greater than 0.35 is considered to be of great influence (Cohen, 1988). In addition, effect size is used as a predictive metric in the sample. The value of f2 is presented in table 8 below. From the results in table 8 shows if leadership has little effect on innovation.

And for innovation has a big effect on teacher performance. In addition, for the work environment on teacher performance cannot be said to have an influence.

Tabel 8 *Effect Size* (F2)

	Innovation	Leadership	Teacher Performance	Work Environment
Innovation			0.645	
Leadership	0.282		0.079	
Teacher Performance				
Working environment	0.062		0.009	

Step 5: The value of Q2, also known as blindfolding (Geisser, 1974; Stone, 1974), is the third metric used to assess predictions. So far, this metric shows predictive power beyond the sample, according to some scholars. However, the prediction metrics of this model are clearly not as powerful as PLSpredict, which will be explained in the next step. When looking at Q2, values above zero have meaning, while values below zero indicate that predictions are irrelevant. In addition, Q2 values greater than 0.25 and 0.50 indicate the relevance of medium and large predictions from the PLS-SEM model. Excessive Q2 values, also known as the quadrilateral Q-test, are used to evaluate the predictive significance of models. A Q2 value greater than 0 indicates that the model has accurate predictive ability for a particular variable, while a lower Q2 value indicates that the model does not have a significant predictive value (Sarstedt, *et al.*, 2017). In this study, measurements using *cross-validated redundancy* (Q2) are shown in Table 9. And the results show if the Q2 results in this study are innovation (0.247) and work environment (0.329).

Tabel 9 *Q2* Square

	SSO	SSE	Q^2 (=1-SSE/SSO
Innovation	1100.000	828.546	0.247
Leadership	1100.000	1100.000	

Teacher Performance	1540.000	1032.724	0.329
Work Environment	1100.000	1100.000	

DISCUSSION

Using a sample of 218 respondents, this study aims to evaluate aspects that affect teacher performance, work environment, innovation, and leadership. There are several variables that can be evaluated, such as teacher performance, leadership, innovation, work environment, and teacher performance. After formulating five hypotheses related to this research question, it can be concluded that overall, each hypothesis proposed has an impact. This shows that we can anticipate a significant correlation between the variables studied with leadership, innovation, work environment, and teacher performance. Innovation affects teacher performance; This hypothesis is in accordance with the results of research from Monoyasa et.al. (2017), which found that teacher innovation affects teacher performance significantly. This means that teacher performance can improve when teacher innovation is influenced, and conversely, teacher performance can decrease when teacher innovation increases. Karim (2020) said that based on the results of research that has been analyzed statistically, it is known that innovative attitudes are partially innovative

The hypothesis that leadership influences innovation is in accordance with the findings of research conducted by Ari Wibowo Sembiring et al. (2023). Transformational leadership styles are thought to help build an atmosphere of innovation and build trust, which in turn influences the atmosphere of innovation. Dynamic leadership enhances the ethical environment and innovation of teachers. The study shows that digital leadership and creative leadership influence innovation. Leadership influences teacher performance; This hypothesis is in accordance with the results of research from Guterres & Supartha (2016), which found that leadership has a significant positive impact on teacher performance.

Juniarti et al. (2020) showed the results of the study that the principal's leadership style has a significant positive impact on teacher performance, as shown by a simple regression line equation. The hypothesis that the work environment affects innovation is in accordance with the findings of research conducted by Peridawaty and Kristinae (2020); The research found that the work environment can significantly increase profitability, but does not reduce the importance of innovation management to increase profitability as well. Creative-innovative behavior, discipline, and work environment affect teacher performance, according to Hadian (2017). The results of a study of 218 respondents showed that there was no relationship between the work environment and teacher performance. Data processed with smart PLS 3.2.9 shows that these results also show that there is no relationship between the work environment and teacher performance.

Conclusion

The results revealed that all hypotheses proposed, related to the influence of leadership variables, innovation, work environment, and teacher performance, showed a significant influence overall. These findings indicate a substantial relationship between these variables. Specifically, teacher innovation has been shown to have a significant positive influence on teacher performance, although note that the higher the level of teacher innovation, the lower teacher performance tends to be. In the context of leadership, both transformational and dynamic, it has a significant positive influence on teacher innovation. Leadership styles, including digital and creative leadership, play an important role in creating an atmosphere that supports the growth of innovation. Furthermore, the results of the study also verify that leadership has a significant positive effect on teacher performance, especially in the context of principal leadership. However, although the work environment is believed to influence innovation, the study did not find any influence of the work environment on teacher performance. The implications of this research findings can be used to formulate more effective education management policies and strategies, especially in improving innovation and leadership in teacher work

environments. However, it is important to conduct further research to explore specific factors in the work environment that may contribute to teacher performance.

Data availability statement

The corresponding author can provide the anonymised dataset, analytical code, and survey instruments upon reasonable request. Private data are de-identified and restricted to academic use by a data-sharing agreement. Institutional barriers prevent public repository use.

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Generative AI statement

AI generators (Grok, Abacus).AI ChatLLM Teams refined language, summarized methods, and formatted tables. Authors checked outputs for accuracy, originality, and reference validity. Authors are responsible; AI is not attributed, and no confidential or personal data was provided without caution.

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