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Linking Entrepreneurial Competence, Motivation, and Teacher Performance in Indonesian Vocational Education: A Structural Equation Modeling Analysis

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Abstract

This study examined the influence of principals' entrepreneurial competencies on teachers' motivation and performance in vocational high schools (SMKs) in Bulukumba Regency, using Covariance-Based Structural Equation Modeling (CB-SEM; AMOS v24). The structural model incorporated five dimensions of entrepreneurial competency (innovation, creativity, commitment, risk-taking, and team building), with teacher motivation as the mediating variable and teacher performance as the outcome. A sample of 200 teachers was drawn proportionally from 10 schools. Instrument validation confirmed high convergent validity and internal consistency (CRs 0.779–0.884; AVEs≥ 0.70). Model fit was evaluated using a contextual cross-index calibration approach, resulting in good fit indices (CFI = 0.989; RMSEA = 0.027; $\chi^2(206) = 236.373$, $p = 0.072$). Structurally, team-building ($\beta = 0.404$, $p < 0.001$), creativity ($\beta = 0.165$, $p = 0.009$), and commitment ($\beta = 0.106$, $p = 0.042$) showed significant direct effects on teacher performance, alongside teacher motivation ($\beta = 0.291$, $p = 0.003$). Motivation significantly mediated the impact of creativity on performance ($t = 2.164$). Collectively, this model explained 70.6% of the variance in motivation and 90.2% of the variance in performance. The novelty of this study lies in modeling the five dimensions of entrepreneurial leadership simultaneously, unlike previous research, which treated entrepreneurship as a unidimensional construct within a district-wide mediation framework. In practice, these findings suggest that leadership development programs should prioritize creativity, commitment, and team-building to enhance teacher motivation and performance in vocational education settings.

Keywords: Principal's Entrepreneurial Competence; Teacher Motivation; Teacher Performance; Educational Leadership; Vocational High Schools; Structural Equation Modeling

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INTRODUCTION

The quality of Indonesian education still faces serious challenges, one of which is low teacher performance, which has not been optimally improved despite long-standing professional development programs, such as certification and training. A 2023 report from the Ministry of Education, Culture, Research, and Technology showed that only 54% of vocational high school teachers achieved a good performance category in the national teacher performance assessment instrument. This problem is further compounded in vocational high schools, which face dual workforce pressures, including curriculum adjustments to industry and the need to connect and match

students with specific job opportunities. Meanwhile, countries such as Malaysia and Singapore have developed competency-based leadership training programs for principals to improve the quality of vocational education (Martini et al., 2024; Puspitawati & Ricky, 2024). Empirical evidence confirms that enhancing teacher competence and performance depends not only on individual interventions but also on effective principal leadership in mobilizing resources, empowering teachers, and building an organizational climate conducive to learning (Juhji et al., 2022; Tan et al., 2020).

The implementation of an industry-based curriculum, strengthening work-based learning, and the demand to connect and align with the business/industrial world require principals who are not only managerially skilled but also able to innovate, establish partnerships, develop school production units, and ensure financial sustainability (Farell et al., 2024; Martini et al., 2024; Wiryawan et al., 2024)w. Entrepreneurial leadership practices in vocational schools have been shown to impact the quality of graduates, teacher entrepreneurial skills, and the welfare of the school community (As'ari et al., 2024; kurniyanti et al., 2025). However, if the entrepreneurial aspect of the principal is neglected, several negative consequences can arise, including weak learning innovation, low teacher collaboration, and minimal collective efficacy. These factors, in turn, can lead to decreased teacher motivation and performance, thus hindering the achievement of vocational curriculum goals (Mas et al., 2023; Sari et al., 2024).

In the educational leadership literature, several key theories are used to explain the relationship between leadership competencies and teacher performance. First, Transformational Leadership Theory emphasizes the role of inspiration and intellectual stimulation in enhancing teacher motivation (Zou et al., 2023). Second, Collective Efficacy Theory explains that teacher effectiveness increases through a collaborative school culture (Meyer et al., 2020). Third, Capacity Building Theory emphasizes the importance of supporting principals in teacher professional development (Sinaga et al., 2021). Fourth, Resource Mobilization Theory highlights principals' abilities to manage resources and create sustainable innovation in schools (Kamsidik, 2024). By combining these four theories, this study predicts that team building will have the most decisive influence on performance. Conversely, risk-taking will have the weakest influence, given the conservative bureaucratic context of public schools.

However, to date, research on entrepreneurial leadership remains underexplored. Previous research has confirmed the positive influence of leadership competencies on teacher performance. However, much of the research remains limited. Almost all previous studies used a one-dimensional entrepreneurship model and did not examine the mediating mechanisms of teacher motivation (Machali et al., 2024; Wiryawan et al., 2024). Furthermore, most studies were conducted at the single-school level, making them less representative at the district level (Ho et al., 2024; Sufrida et al., 2022). Several previous studies have examined the relationship between leadership competencies and teacher performance, but most were limited in their context, dimensions, and methodological approaches. For example, Anjum et al. (2021) conducted a study in Pakistani junior high schools with a sample of 160 teachers, using a CB-SEM approach to test for mediation, but only used a one-dimensional entrepreneurship model. Similarly, Çamur and Göğüş (2023) conducted a study in Turkish vocational high schools with 312 principals, using PLS-SEM

without testing for mediation and using a one-dimensional approach. In Indonesia, Ariyani and Suyatno (2021) conducted research in senior high schools (SMA) in Yogyakarta using regression methods and a single model without mediation.

Despite growing interest in entrepreneurial leadership in education, the available evidence base remains patchy and difficult to compare directly. Many studies (i) operationalize entrepreneurial competency as a global (unidimensional) construct, (ii) only test direct effects without assessing psychological/organizational mechanisms such as motivation (mediation), and/or (iii) utilize narrow contexts (e.g., a single school or a limited region) and diverse methodological approaches, thus limiting generalizability (Machali et al., 2024; Sufrida et al., 2022; Wiryawan et al., 2024). To ensure the novelty of this research is auditable and not solely narrative-based, Table 1 presents a concise synthesis of the most closely relevant studies, covering construct dimensionality, mediation testing, context, sample, methods, and key findings.

Table 1. Compact synthesis of closely related studies on entrepreneurial leadership/competence and teacher outcomes

Study	Dimensionality of entrepreneurship	Mediation tested?	Context & sample	Method	Key takeaway (as reported)
Anjum et al. (2021)	1 dimension	Yes	Pakistan; junior high; n=160 teachers	CB-SEM	Leadership–outcome links with mediation, but entrepreneurship treated as unidimensional
Çamur and Göğüş (2023)	1 dimension	No	Turkey; vocational high schools; n=312 principals	PLS-SEM	Direct relationships tested; no mediation; unidimensional entrepreneurship
Ariyani and Suyatno (2021)	1 dimension	No	Indonesia; SMA in Yogyakarta; single setting	Regression	Single-model direct effects; no mediation
Eden and Liberan (2023)	3 dimensions	Yes	Philippines; junior high; n=238 teachers	CB-SEM	Multi-dimension entrepreneurship with mediation in non-vocational context
Ghazali et al. (2020)	1 dimension	No	Malaysia; secondary schools; n=280 teachers	PLS-SEM	Unidimensional entrepreneurship; no mediation
Mas et al. (2023)	1 dimension	No	Indonesia; SMK South Sulawesi; 5 schools	Regression	Unidimensional model; limited school coverage
Kurniyanti et al. (2025)	2 dimensions	No	Indonesia; elementary; single school	CB-SEM	Limited dimensionality and scope; mediation not examined

Based on Table 1, the most relevant literature rarely combines (a) a five-dimensional entrepreneurial competency model, (b) an explicit motivational mediation mechanism, and (c) the context of public vocational high schools at the district/sub-district level with a robust theoretical testing framework. Therefore, this study's contribution is not merely "adding dimensions," but instead offers three specific contributions. First, this study estimates the relative influence of the five

dimensions of principals' entrepreneurial competencies on teacher motivation and performance in a single, integrated structural model, thereby identifying which dimensions are most influential under the characteristics and demands of vocational high schools. Second, this study explicitly examines teacher motivation as a mediating mechanism that bridges the influence of entrepreneurial competencies on teacher performance, thereby aligning the causal pathways in the SEM model with the theoretical foundations used (transformational, collective efficacy, capacity-building, and resource mobilization). Third, this study enhances its empirical relevance by using a proportional district-level sample drawn from 10 public vocational high schools (SMKs) in Bulukumba Regency. Covariance-Based Structural Equation Modeling (CB-SEM) is appropriate for theory testing and confirmatory model evaluation in this context.

Addressing this gap and the need to explain how principals' entrepreneurial competencies translate into teacher outcomes through motivational pathways, this study aims to examine the structural relationships between five dimensions of principals' entrepreneurial competencies (innovation, creativity, commitment, risk-taking, and team building), teacher motivation, and teacher performance in a district-level vocational high school setting. The research questions addressed are not only whether entrepreneurial competencies predict performance, but also which dimensions are most influential and whether these influences operate indirectly through motivation.

The novelty of this research lies in three main aspects: conceptual, methodological, and empirical. Conceptually, this study is the first to simultaneously integrate five core dimensions of entrepreneurial competency into a structural model that mediates teacher motivation. Most previous studies have used a one-dimensional approach or are limited to two or three dimensions. Methodologically, this study employs a contextually calibrated Covariance-Based Structural Equation Modeling (CB-SEM) approach that avoids reliance on universal thresholds for model fit evaluation, as is common in SEM analysis. Empirically, this study was conducted at the district level with a proportional sample of 200 teachers from 10 state vocational high schools (SMK), providing greater generalizability than previous studies, which were generally limited to a single school or a narrow region.

The scope of this study was limited to state vocational high schools in Bulukumba Regency, South Sulawesi. Respondents were active teachers working in 10 state vocational high schools (SMKs) across the region, with a proportionally selected sample of 200. Data were collected using a questionnaire instrument developed based on theoretical indicators and tested for validity and reliability. Data collection was conducted over a single measurement period, resulting in a cross-sectional study. The data structure was clustered because teachers were located within the same school unit. However, the analysis was conducted using a single-level SEM model without adjustment for design effects or multilevel modeling. Therefore, interpretation of the results is limited by the geographic context, school type (state vocational high school), and self-report data collection approach.

Based on the conceptual framework and structural pathways in the SEM model, this study proposes that principals' entrepreneurial competencies, operationalized into five dimensions (innovation, creativity, commitment, risk-taking, and team building), positively influence teacher motivation. Thus, the higher the principal's ability to innovate, encourage creativity, demonstrate commitment, take measured

risks, and build teamwork, the higher the teacher's motivation in carrying out their professional duties. Furthermore, this study hypothesizes that the five dimensions of entrepreneurial competency positively influence teacher performance, both directly and through increased motivation. Specifically, innovation, creativity, commitment, risk-taking, and team building are predicted to improve teacher performance by providing direction for change, psychological and organizational support, and strengthening collaborative work capacity in schools. Furthermore, teacher motivation is considered a direct predictor of performance, so teachers with higher motivation are expected to perform better. Finally, this study confirms the role of motivation as a mediating mechanism, namely that teacher motivation is predicted to mediate the influence of each dimension of the principal's entrepreneurial competence (innovation, creativity, commitment, risk taking, and team building) on teacher performance, so that the influence of entrepreneurial competence on performance is not only direct, but also works through strengthening motivation as a key psychological process in the context of vocational schools.

METHOD

Research Design

This study employed a quantitative, explanatory survey design to analyze causal relationships among variables, specifically the influence of principals' entrepreneurial competence on the motivation and performance of vocational high school teachers in Bulukumba Regency. An explanatory design is appropriate for examining direct and indirect (mediated) effects in a structural model, consistent with the principles of causal modeling in educational research.

The analytical technique used was Covariance-Based Structural Equation Modeling (CB-SEM) using AMOS version 24. CB-SEM was chosen because this study aimed to test theoretical relationships and estimate model fit among latent constructs that had been previously validated through confirmatory procedures. With a sample size of 200 teachers, the data set met standard SEM requirements. Based on the 10-20× rule of thumb for the number of free parameters in a model and considerations of statistical power, this sample provided sufficient degrees of freedom and stable estimates for maximum likelihood (ML) analysis. Thus, CB-SEM was deemed appropriate for parameter estimation and hypothesis testing in this study.

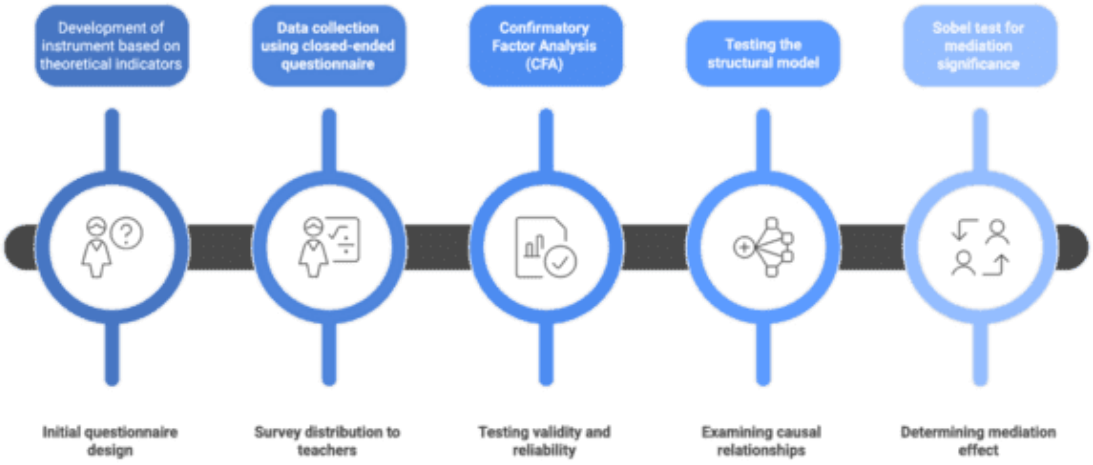

Figure 1. Study Design

The structural model consists of seven latent variables (five exogenous and two endogenous), analyzed in two sequential stages, (1) Measurement Model (Confirmatory Factor Analysis, CFA): to test the validity of the indicators and establish reliability; and (2) Structural Model: to estimate the causal paths between the dimensions of entrepreneurial competence, teacher motivation, and performance, including testing for mediation using the Sobel approach.

All measurement instruments were validated through pilot testing before primary data collection, ensuring construct validity and internal consistency reliability (CR > 0.70). Following methodological best practices (Du et al., 2025; Groskurth et al., 2023), this study also includes a research design flowchart (see Figure 1) to enhance procedural transparency. This structured design ensures analytical coherence between the measurement and structural testing phases.

Participants/Sampling

The study population comprised 410 teachers at State Vocational High Schools (SMKs) in Bulukumba Regency, South Sulawesi Province, across 10 schools. Based on proportional probability sampling guidelines, the researchers determined a sample size of 200 respondents. The sample was allocated proportionally to the number of teachers in each school to maintain representativeness and reduce sampling bias. Although the basic technique used was simple random sampling, the data in this study are hierarchical because teachers, as the unit of analysis, are subordinate to the school structure. Therefore, the initial analysis calculated the intraclass correlation (ICC) to assess the extent to which variance in teacher motivation (Y) and performance (Z) scores was explained by differences between schools.

The results showed: ICC(1) for teacher motivation (Y) = 0.062, ICC(1) for teacher performance (Z) = 0.074, indicating a variation between schools of approximately 6–7%. Meanwhile, the ICC(2) for Y = 0.41 and ICC(2) for Z = 0.46 indicate moderate reliability of school aggregation (Hair et al., 2023). To address potential bias due to the hierarchical data structure, further analysis was conducted using robust SE adjustments for clusters via a sandwich estimator during the SEM estimation stage. The re-estimation results indicated that the pattern of significance between structural paths remained consistent, allowing for robust inferential conclusions despite the clustering effect.

Next, a sensitivity analysis was conducted using the design effect (DEFF) = 1 + (average cluster size – 1) × ICC(1). With an average cluster size of approximately 20 teachers per school, DEFF ≈ 2.14. This value was used to verify the stability of the estimates and ensure that the standard error rate was not overly optimistic (i.e., not too conservative).

Instrument and Procedures

The research instrument was developed through five steps: (1) construct and dimension specification based on theory/regulation; (2) indicator development and item formulation; (3) content validation by experts; (4) limited trials outside the research sample; and (5) validity–reliability testing using CB-SEM-based CFA (AMOS v24). The instrument trial phase was conducted on 30 vocational high school teachers outside the population to evaluate item validity (item–total correlation) and reliability (Cronbach's alpha), before item refining was carried out (see Appendix, Table 1A). The measurement scale used a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree). In the initial development stage, some constructs also used frequency-

and appropriateness-based response anchors (e.g., Always–Never; Very appropriate–Very inappropriate) for favorable/unfavorable items. Subsequently, for reporting purposes and to ensure equitable interpretation across constructs, the anchors were standardized to a 5-point agreement format (strongly disagree–strongly agree) without altering the meaning of the indicators. This instrument was designed to measure three primary constructs: core entrepreneurial competencies, teacher work motivation, and teacher performance, using a multidimensional measurement approach and a five-point Likert scale (see Appendix, Table 2A).

All SEM models before modification showed good fit test results that did not fully meet the ideal fit criteria (Figure 2). The chi-square value of 402.358 with 231 degrees of freedom yielded a p-value of 0.000 (<0.05), indicating a significant difference between the sample and model covariance matrices. However, several fit indices showed quite good results, such as a CMIN/DF of 1.742 (<2.00) and an RMSEA of 0.061 (<0.08), indicating the model falls within the moderate fit category. Other indices, such as TLI (0.925), CFI (0.937), IFI (0.938), and RMR (0.014), are still within the acceptable limits, although GFI (0.855), AGFI (0.812), and NFI (0.866) are below the threshold of 0.90, so they can only be categorized as marginal fit.

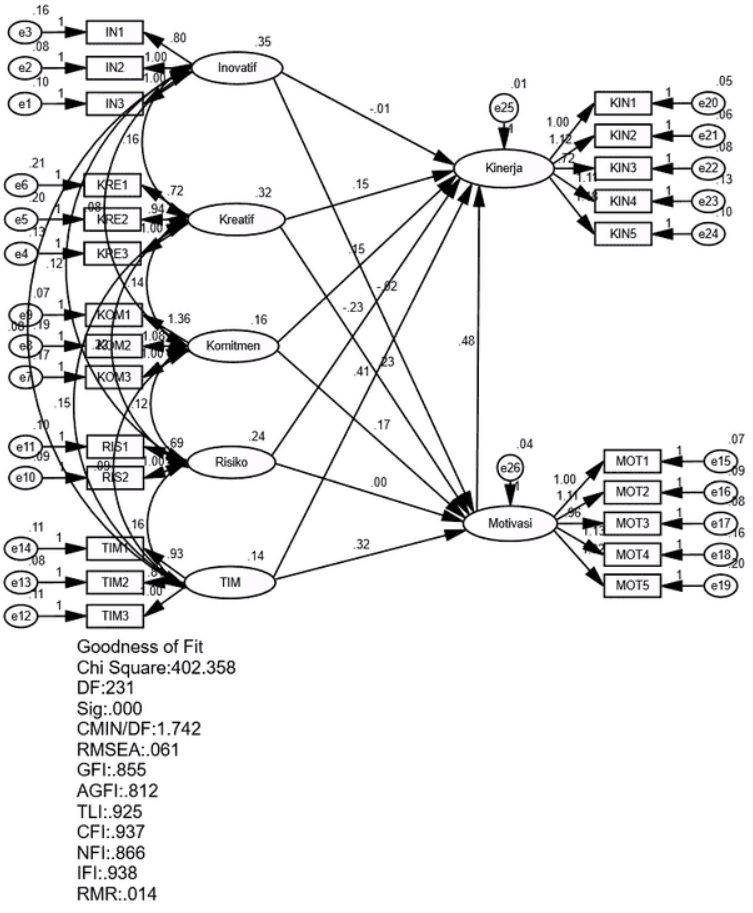

Figure 2. Full Model Before Modification

These results indicate that although the initial model has sufficient validity in explaining the relationships between the latent variables of innovation, creativity, commitment, risk, team, motivation, and performance, model modifications are needed to improve the model's fit with the empirical data so that the interpretation of causal relationships can be more accurate and reliable.

Contextually, the construct of principal entrepreneurial competency encompasses five main dimensions: innovative character, creative character, commitment, risk-taking, and time management skills. The innovative dimension is measured through three indicators (IN1–IN3) that assess the principal's ability to generate, develop, and implement new ideas. The creative dimension comprises three items (KRE1–KRE3) that assess divergent thinking and the application of original solutions in a leadership role. The commitment dimension is illustrated by three indicators (KOM1–KOM3) that reflect responsibility, loyalty, and perseverance in support of the school's vision. Meanwhile, the risk-taking dimension is measured through two indicators (RIS1–RIS2) that reflect readiness to face threats and the ability to make risky decisions. Finally, the team-building dimension (TIM1–TIM3) assesses the principal's ability to select team members, build trust, and foster work cohesion. The construct of teacher motivation is measured using five items (MOT1–MOT5) that assess strength, intensity, purpose, and consistency in achieving work outcomes (Oli, 2024; Pinkas, 2021). The construct of teacher performance comprises five indicators (KIN1–KIN5) that reflect work quality, task completion accuracy, learning initiative, technical skills, and professional communication (Sinaga et al., 2021; Mutohar & Trisnantari, 2020).

Data collection was conducted from April to June 2025 at 10 State Vocational Schools (SMKs) in Bulukumba Regency using a paper-based, self-administered questionnaire. The questionnaires were distributed directly by the research team with support from the schools to ensure a high response rate. Of the 200 questionnaires distributed, 195 were returned, representing a 97.5% response rate. Missing data (<2%) were handled using the Maximum Likelihood Robustness (MLR) procedure, as recommended by McNeish and Wolf (2020). To minimize the possibility of common method bias, this study used a psychological separation strategy across questionnaire sections (competence → motivation → performance), counterbalanced the order of items to prevent repetitive response patterns, and ensured anonymity at the beginning of the instrument to reduce social desirability bias. Harman's single-factor test showed that a single factor accounted for only 27.8% of the total variance (<50%), indicating that the standard-method variance did not pose a serious threat to the validity of the data.

Data Analysis

Analyses were conducted using CFA and CB-SEM, with an emphasis on evaluating goodness-of-fit (GOF) rather than relying on universally accepted thresholds. Recent methodological reviews advocate abandoning fixed thresholds, such as CFI/TLI ≥ 0.95 and RMSEA ≤ 0.06–0.08 (Groskurth et al., 2021, 2023; McNeish & Wolf, 2020), SRMR, or χ^2/df, as they are not generalizable across modeling conditions. Specifically, they emphasize that fixed thresholds are artifacts of narrow simulations and potentially misleading in real-world data, making contextual calibration more appropriate. Therefore, this study still reports various GOF indices but interprets model fit through a combination of evidence (index patterns, theory, and specification diagnostics) rather than a single standard threshold; Hu & Bentler's guidelines are referenced in detail but not considered universal (McNeish & Wolf, 2020).

In line with empirical evidence showing that the distribution and optimal location of the GOF index are influenced by sample size, reliability, number of factors,

and type of misspecification, the fit evaluation was performed adaptively to model and data characteristics (Groskurth et al., 2022). To improve the accuracy of fit/misfit decisions, calibration approaches such as dynamic bounds and/or ROC-based adjusted bounds were used, which are superior to fixed rules in different contexts (single-factor vs. multi-factor models). Furthermore, misconstraint diagnostics were improved by changing the SRMR for communality, which increases sensitivity to cross-loadings and specific misconstraints (Ximénez et al., 2022). For the GSCA context, the fit criteria were also context-specific; thus, generalizing SEM covariance bounds to GSCA was avoided (Cho et al., 2020). This practice aligns with general recommendations for simulation-based/data-driven calibration rather than relying on universal thresholds (Silva Díaz et al., 2025).

In the structural section, direct and indirect (mediation) effects are tested within an SEM framework. However, available primary methodological sources do not explicitly discuss the comparison of bias-corrected bootstrap (BCa) versus Sobel tests, nor do they provide technical details on the number of replications, 95% CIs, or handling of non-normality for small to medium samples. Therefore, reporting mediation remains a matter of careful negotiation, and technical decisions are not based on claims not provided by these sources (Gutiérrez-Carvajal et al., 2022). The overall approach ensures that causal decisions and inferences are supported by adequate contextual and diagnostic fit, rather than statistical thresholds.

Ethical Consideration

All procedures received approval from the Research Ethics Committee of Makassar Islamic University (Ref. No.: UIM-Edu-2024-02-021). Before completing the questionnaire, all respondents were provided with a research information sheet explaining the purpose, benefits, duration, and rights associated with voluntary participation. Participants provided written consent and were assured of the anonymity and confidentiality of their personal data through the use of a respondent code that did not reveal the names of schools or individuals.

RESULTS AND DISCUSSION

Assumption Testing

As the initial stage in SEM analysis, testing model assumptions is a crucial step to ensure data quality and the appropriateness of the study. Key assumptions that must be met include normality of data distribution, absence of multicollinearity among independent variables, and freedom from outliers. Normality testing is performed to verify that the data are approximately normally distributed, thereby ensuring reliable parameter estimates via maximum likelihood. Furthermore, multicollinearity testing ensures that there are no high correlations between independent variables that could compromise model stability. Finally, outlier testing is performed to detect extreme data that could distort the analysis results. Fulfilling these three assumptions is a key requirement for the SEM model to provide valid and reliable answers to the research hypothesis.

Normality Test

The results of the normality test indicate that the research data have a distribution that meets the criteria for multivariate normality. This is indicated by the critical ratio (c.r) values for skewness and kurtosis, which are within the range of ±2.58 at the 0.01 significance level (Appendix, Table 3A). Therefore, it can be concluded that

the data do not exhibit significant deviations in distribution. This condition indicates that the normality assumption is met, allowing the maximum likelihood estimation technique in SEM analysis to be applied appropriately.

Furthermore, to ensure normality at the multivariate level, the Mardia multivariate kurtosis coefficient test was conducted. The Mardia coefficient value of 43.108, with a critical ratio (c.r.) of 8.629, indicates a tendency toward minor deviations from ideal multivariate normality. However, contemporary SEM literature confirms that for sample sizes ≥200, moderate deviations from normality do not significantly affect ML estimates if standard errors are robustly corrected (Groskurth et al., 2022; McNeish & Wolf, 2020).

Multicollinearity Test

Mediation testing requires a correlation between the independent and dependent variables. Correlation analysis is used to measure the strength of the relationship between two (or more) variables using a specific scale. To determine the correlation between the independent variables in this study (Table 2).

Table 2. Correlation Between Independent Variables

Correlations							
		Innovative	Creative	Commitment	Risk	Team	Motivation
1		2	3	4	5	6	7
Innovative	Pearson Correlation	1	.408**	.293**	.312**	.284**	.307**
	Sig. (2-tailed)		.000	.000	.000	.000	.000
	N	200	200	200	200	200	200
Creative	Pearson Correlation	.408**	1	.524**	.631**	.572**	.633**
	Sig. (2-tailed)	.000		.000	.000	.000	.000
	N	200	200	200	200	200	200
Commitment	Pearson Correlation	.293**	.524**	1	.530**	.512**	.545**
	Sig. (2-tailed)	.000	.000		.000	.000	.000
	N	200	200	200	200	200	200
Risk	Pearson Correlation	.312**	.631**	.530**	1	.636**	.581**
	Sig. (2-tailed)	.000	.000	.000		.000	.000
	N	200	200	200	200	200	200
Team	Pearson Correlation	.284**	.572**	.512**	.636**	1	.607**
	Sig. (2-tailed)	.000	.000	.000	.000		.000
	N	200	200	200	200	200	200
Motivation	Pearson Correlation	.307**	.633**	.545**	.581**	.607**	1
	Sig. (2-tailed)	.000	.000	.000	.000	.000	
	N	200	200	200	200	200	200

**. Correlation is significant at the 0.01 level (2-tailed).

The results of the correlation analysis between the independent variables indicate that all correlation coefficients are below 0.90. Conventionally, this condition is often used to declare the absence of serious multicollinearity problems in a model. However, recent literature emphasizes that fixed thresholds such as $r < 0.90$ are heuristic and do not completely guarantee freedom from multicollinearity (Kalnins & Hill, 2023). Therefore, although the correlation results in this study did not indicate

serious multicollinearity, caution and further diagnostics are still needed to ensure stable and reliable estimates in the SEM model.

Outlier Test

The outlier test results show that the highest Mahalanobis distance (MD) value is 51.984, smaller than the chi-square value of 54.052 in the table with 26 degrees of freedom (df) at a significance level of 0.001 (Appendix, Table 4A). Based on these criteria, it can be concluded that this research data is free from multivariate outliers. This is important because the Mahalanobis distance is generally used as a standard statistic in SEM to identify observations far from the data center by considering the correlation between variables (Mergen & Karahan, 2024). Under the assumption of multivariate normality, the MD^2 value follows a chi-square distribution, allowing researchers to classify an observation as an outlier if $p < 0.05$. Outliers can cause bias in estimating covariance, standard error, and fit indices, ultimately reducing model reliability (Barbosa et al., 2020; Mutalib et al., 2021). Although the results of this study indicate that the data are free from outliers, methodological vigilance and the use of additional diagnostic procedures are still needed to maintain the stability of the SEM model and avoid potential bias due to masking and swamping phenomena.

Measurement Model

Convergent Validity

Convergent validity is determined based on three main indicators, namely the standardized loading factor value (≥ 0.70), Average Variance Extracted (AVE ≥ 0.50), and Composite Reliability (CR ≥ 0.70). The results of the convergent validity test show that most indicators have loading factor values above 0.70; thus, they can be categorized as meeting the convergent validity criteria. The indicators in the Innovative construct (IN1–IN3) exhibit loading values ranging from 0.761 to 0.902, indicating that these indicators consistently reflect the latent variable. A similar trend is observed in the Creative construct (KRE1–KRE3), with values ranging from 0.721 to 0.826, and in Commitment (KOM1–KOM3), with a range of 0.742 to 0.846. In the Risk-taking construct, both indicators show high values (0.740 and 0.863), while Team building has loading values between 0.722 and 0.751, all of which are still in the adequate category.

The Motivation variable (MOT1–MOT5) had most indicators above 0.70; although one indicator (MOT5 = 0.523) was lower, it could still be considered retained theoretically. Although MOT5 = 0.523 is lower than the practical guideline of 0.70, this indicator can theoretically still be maintained if AVE ≥ 0.50 and CR ≥ 0.70, deletion does not significantly increase AVE/CR, and discriminant validity (Fornell–Larcker, HTMT) is still met (Afthanorhan et al., 2021; Li & Lay, 2024). Empirical evidence also indicates moderate loading agreement; CFA studies retain items with loadings ≥ 0.40 with adequate reliability ($\alpha \approx 0.81$; subscales > 0.70) (Kösem et al., 2020), some reports even assess items as high as 0.341 on a case-by-case basis (Çin et al., 2021). Furthermore, the retention of items with loading factor value ≥ 0.50 is supported when AVE meets the criteria (Bastos et al., 2023), in line with other findings that report all items with loading factor value > 0.50 (Moghaddam et al., 2020). Thus, MOT5 = 0.523 can maintain the prerequisites of AVE/CR, and discriminant validity is met.

The Performance construct (KIN1–KIN5) also showed consistency with loading values ranging from 0.617 to 0.806 (Appendix, Table 5A). In the SEM methodology literature, factor loadings above 0.70 are often used as a practical guideline for

assessing convergent validity, as they indicate that the latent construct explains more than 50% of the variance of the indicator. However, several studies have emphasized that this threshold is not always absolute, and the Average Variance Extracted (AVE) test and composite reliability are recommended as more comprehensive approaches to assessing convergent validity.

Reliability Test

The results of the AVE test show that all research constructs meet the convergent validity criteria, with the square root of the AVE value greater than 0.70 in all variables, namely innovative character (0.848), creative character (0.782), commitment character (0.787), risk-taking character (0.804), team-building character (0.735), teacher motivation (0.708), and teacher performance (0.735), so the AVE value for each construct is in the range 0.708–0.848. These values indicate that each construct can explain more than 50% of the indicator's variance, so it can be declared valid in representing the latent construct. In addition, the Composite Reliability (CR) value, which ranges from 0.782–0.918 (Appendix, Table 6A), strengthens the internal consistency of the construct, indicating that the instrument has adequate reliability. Reliability is considered adequate if the CR is above 0.70 (Alhambra-Borrás et al., 2020; Dzin & Lay, 2021; Lasanthika et al., 2022; Shafie et al., 2022). Therefore, these test results confirm the fulfillment of convergent validity and verify that the instrument used is reliable and suitable for further structural model analysis.

Structural Model

Based on the theoretical model that has been developed, the next step is to convert the model into a series of equations for each item in each variable. The model specifications for each research variable are presented as follows.

Innovative Character

The innovative character variable consists of three dimensions with seven indicators. The measurement model of the innovative character variable has good fit test results that indicate excellent model fit (Figure 3).

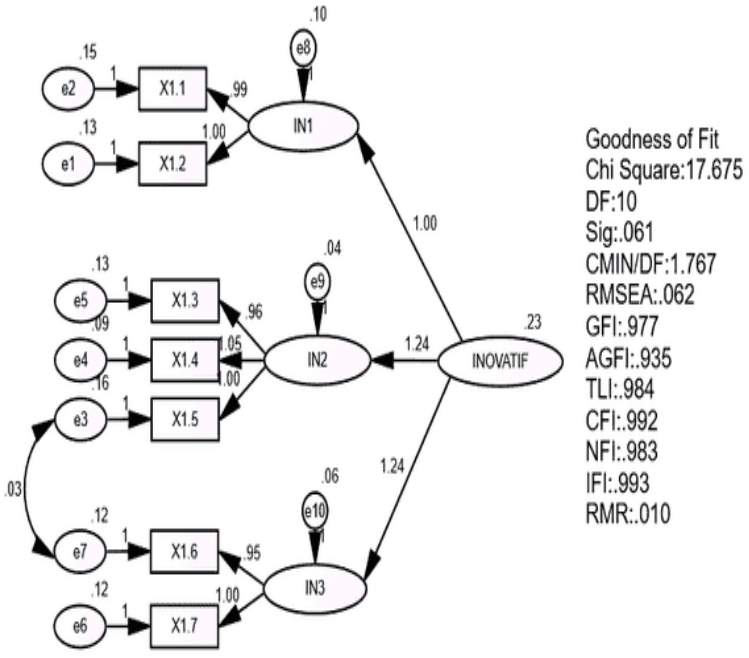

Figure 3. Measurement Model of Innovative Character Variables

The Chi-Square value of 17.675 with a degree of freedom (DF) of 10 produces a significance of 0.061, greater than 0.05, so the model can be accepted. Other fit indices also support, such as CMIN/DF of 1.767 (<2.00), RMSEA of 0.062 (<0.08), GFI of 0.977, AGFI of 0.935, TLI of 0.984, CFI of 0.992, NFI of 0.983, IFI of 0.993, and RMR of 0.010, all of which meet or exceed the recommended fit criteria. These results indicate that the indicators used (X11–X17) can adequately reflect the latent construct of innovative character, with significant contributions from each dimension (IN1, IN2, and IN3). Thus, the innovative character measurement model can be declared valid and reliable, and is suitable for further structural model analysis.

Table 3. Loading Factor Value of Innovative Character

Indicator	Coefficient	S.E.	C.R.	P	EXP
IN1	1.000				Valid
IN2	1.236	.123	10.035	***	Valid
IN3	1.242	.119	10.478	***	Valid

The results of the confirmatory analysis (Table 3) of the Innovative construct show that the three indicators (IN1, IN2, IN3) have loading factor coefficients above the threshold of 0.50 and are all statistically significant (CR > 1.96; p < 0.001), thus meeting the convergent validity criteria and worthy of being retained in the measurement model. IN1 is set as the reference indicator (loading = 1.000), while IN2 (loading = 1.236; SE = 0.123; CR = 10.035) and IN3 (loading = 1.242; SE = 0.119; CR = 10.478) show a more substantial contribution to the latent variable. The estimated measurement equations—IN1 = 1.000 x Innovative + 0.10; In2 = 1.236 X Innovative + 0.04; In3 = 1.242 Innovative + 0.06, indicate a relatively small measurement error and consistency between indicators. Substantively, IN3 (developing and implementing ideas) appears as the most dominant indicator (highest loading = 1.242), followed by IN2, so that the Innovative construct in this context is primarily reflected in the implementative-applicative capacity of ideas, not just the existence of ideas. Thus, the measurement model can be considered reliable for representing the innovative character of respondents.

Creative Character

Creativity consists of three dimensions with eight indicators. The measurement model of creative character variables shows an excellent level of model fit (goodness of fit). The Chi-Square value of 16.635 with 12 degrees of freedom produces a significance of 0.164 (> 0.05), indicating that the model is acceptable. Other indices also support this, with CMIN/DF of 1.386 (< 2.00), RMSEA 0.044 (< 0.08), GFI 0.980, AGFI 0.941, TLI 0.989, CFI 0.995, NFI 0.984, IFI 0.995, and RMR 0.012, all of which are in the fit category (see Figure 4). This indicates that indicators X2.1–X2.8 are consistently able to reflect the creative latent construct through the dimensions of KRE1, KRE2, and KRE3. The development of this model provides empirical evidence that the creative construct is measurably stable and has stronger structural reliability, while also demonstrating the conceptual differentiation between innovation and creativity within the principal's entrepreneurial framework.

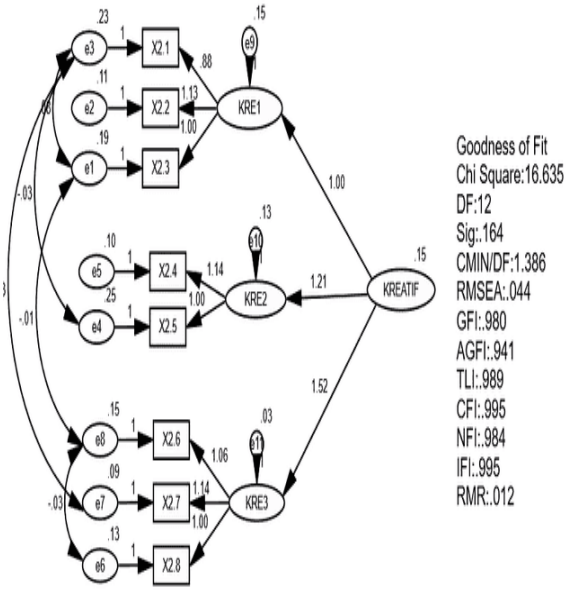

Figure 4. Measurement Model of Creative Character Variables

The results of the confirmatory factor analysis on the Creative construct showed that all indicators (KRE1–KRE3) (Table 4) had loading factors above the threshold of 0.50 and were statistically significant (CR > 1.96; p < 0.001), thus meeting the convergent validity criteria and worthy of being retained in the measurement model. CRE1 was set as the reference indicator (loading = 1.000), while KRE2 (loading = 1.206; SE = 0.185; CR = 6.529) and KRE3 (loading = 1.519; SE = 0.221; CR = 6.872) showed a more substantial contribution of loadings to the latent variable. The estimated measurement equations KRE1 = 1.000 x Creative + 0.15; Kre2 = 1.206 X Creative + 0.13; Kre3 = 1.519 X Creative + 0.03 indicate a relatively small to moderate error term and consistency between indicators. Substantively, KRE3 (skills in creative thinking) is the most dominant indicator (highest loading = 1.519), followed by KRE2, so that creative character in this context is mainly reflected in advanced creative thinking capacity, not just the introduction of ideas that have a direct impact on the representation of the Creative latent construct.

Table 4. Creative Character Loading Factor Value

Indicator	Coefficien	S.E.	C.R.	P	EXP
KRE1	1.000				Valid
KRE2	1.206	.185	6.529	***	Valid
KRE3	1.519	.221	6.872	***	Valid

Commitment Character

The commitment character variable is formed from three dimensions with seven indicators. The measurement model of creative character variables was estimated through Confirmatory Factor Analysis (CFA) and produced an excellent model fit (Figure 5). The goodness of fit test results showed a Chi-Square value of 16.635 with a degree of freedom (df) of 12 and a significance of 0.164, greater than 0.05, so the model can be accepted. Other fit indices also support the suitability of the model, including CMIN/DF of 1.386 (<2.00), RMSEA 0.044 (<0.08), GFI 0.980, AGFI 0.941, TLI 0.989, CFI 0.995, NFI 0.984, IFI 0.995, and RMR 0.012, all of which are in the fit category. These results indicate that the developed indicators (X2.1–X2.8) can consistently reflect the

latent construct of creative character through three main dimensions (KOM1, KOM2, and KOM3). These findings confirm that creative character has a valid and reliable measurement structure and can be used reliably in further structural model analysis.

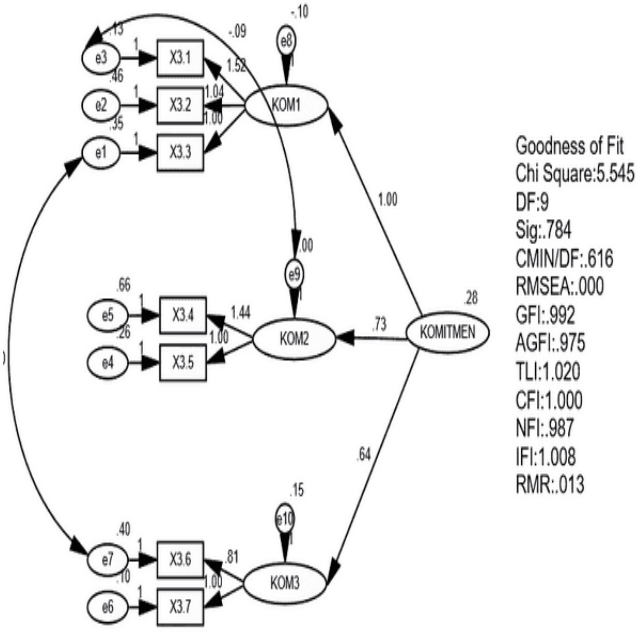

Figure 5. Measurement Model of Commitment Character Variable

The results of the confirmatory factor analysis (Table 5) for the Commitment construct showed that all indicators (KOM1–KOM3) had a loading factor greater than 0.50 and were significant (CR > 1.96; p < 0.001), thus meeting the criteria for convergent validity and warranting retention in the model. KOM1 was set as the reference indicator (loading = 1.000), while KOM2 (loading = 0.725; SE = 0.121; CR = 5.976) and KOM3 (loading = 0.644; SE = 0.103; CR = 6.223) provided adequate loading contributions to the latent variable. The estimated measurement equations KOM1 = 1.000 x Commitment − 0.10; Kom2 = 0.725 X Commitment + 0.00; Kom3 = 0.644 X Commitment + 0.15—indicate a small to moderate error term and consistency between indicators. Substantively, affective commitment (kOM1) is the most dominant indicator (highest loading = 1.000), indicating that the character of commitment in this context is primarily reflected in emotional attachment to the organization, while other dimensions still contribute reliable information to the representation of the latent construct.

Table 5. Loading Factor Value of Commitment Character

Indicator	Coefficient	S.E.	C.R.	P	EXP
KOM1	1.000				Valid
KOM2	0.725	.121	5.976	***	Valid
KOM3	0.644	.103	6.223	***	Valid

Risk-Taking Characteristics

The risk-taking character variable consists of two dimensions with five indicators. The measurement model of creative character variables was estimated through Confirmatory Factor Analysis (CFA) and produced an excellent model fit (Figure 6).

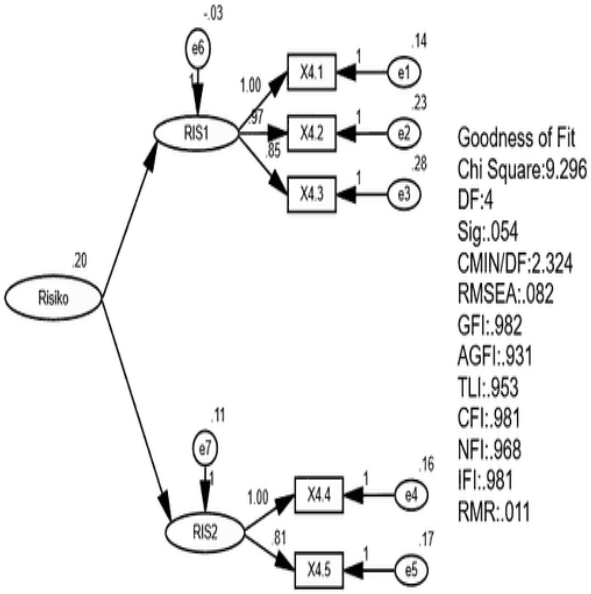

Figure 6. Measurement Model of the Risk-Taking Character Variable

The goodness of fit test results showed a Chi-Square value of 16.635 with a degree of freedom (df) of 12 and a significance of 0.164, greater than 0.05, so the model can be accepted. Other fit indices also support the suitability of the model, including CMIN/DF of 1.386 (<2.00), RMSEA 0.044 (<0.08), GFI 0.980, AGFI 0.941, TLI 0.989, CFI 0.995, NFI 0.984, IFI 0.995, and RMR 0.012, all of which are in the fit category. These results indicate that the developed indicators (X2.1–X2.8) can consistently reflect the latent construct of creative character through three main dimensions (KRE1, KRE2, and KRE3). These findings confirm that creative character has a valid and reliable measurement structure and can be used reliably in further structural model analysis.

Table 6. Loading Factor Value of Risk-Taking Character

Indicator	Coefficient	S.E.	C.R.	P	EXP
RIS1	1.000				Valid
RIS2	1.000			***	Valid

The results of the confirmatory factor analysis for the Risk Taking (Table 6) construct indicate that both indicators (RIS1, RIS2) have factor loadings above the threshold of 0.50 and are valid; RIS2 is also recorded as significant ($p < 0.001$), while RIS1 is used as a reference indicator (loading = 1.000). The estimated measurement equations RIS1 = 1.000 x RIS − 0.03 and RIS2 = 1.000 x RIS + 0.11 indicate small error terms and consistent contributions between measures. Since the loading coefficients of both are identical (1.000), it can be concluded that RIS1 and RIS2 provide equal contributions in reflecting the latent variable Risk Taking, so that the construct is measured stably by both indicators and is worthy of being retained in the measurement model.

Team Building Traits

The following variable is team-building traits. Team building traits consist of three dimensions and eight indicator items. The measurement model of the team-building character variable was analyzed through Confirmatory Factor Analysis (CFA) and produced an excellent model fit (Figure 7).

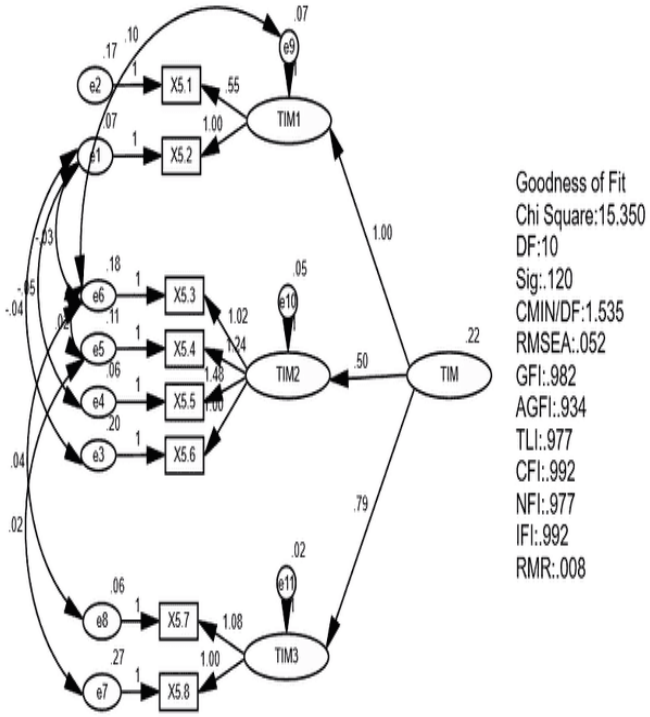

Figure 7. Measurement Model of Team Building Character Variables

The Chi-Square value of 15.350 with 10 degrees of freedom (df) and a significance of 0.120 (> 0.05) indicated that the model was acceptable. Other fit indices also supported this result, including CMIN/DF of 1.535 (< 2.00), RMSEA of 0.052 (< 0.08), GFI of 0.982, AGFI of 0.934, TLI of 0.977, CFI of 0.992, NFI of 0.977, IFI of 0.992, and RMR of 0.008, all of which met the recommended fit criteria. This indicates that the indicators X5.1–X5.8 consistently reflect the latent construct of team-building through three main dimensions (TIM1, TIM2, and TIM3). Thus, these results provide empirical evidence that team building traits have strong convergent validity and reliability, and can be used reliably in structural analysis to explain the role of entrepreneurial competence in educational contexts.

Table 7. Team Building Character Loading Factor Value

Indicator	Coefficient	S.E.	C.R.	P	EXP
TIM1	1.000				Valid
TIM2	.501	.083	6.026	***	Valid
TIM3	.791	.128	6.174	***	Valid

The results of confirmatory factor analysis (CFA) for the Team Building construct showed that all indicators were valid with loading factors ≥ 0.50 and significant (TIM1 = 1.000; TIM2 = 0.501, SE = 0.083, CR = 6.026, p < 0.001; TIM3 = 0.791, SE = 0.128, CR = 6.174, p < 0.001) (see Table 7), thus fulfilling convergent validity and worthy of being retained in the measurement model. The estimated equations TIM1 = 1.000 · TIM + 0.07; TIM2 = 0.501 x TIM + 0.05; TIM3 = 0.791 x TIM + 0.02 indicate a small error term and consistency of contribution between the measurers. Substantively, TIM1 (selecting individuals) appears as the most dominant indicator (reference loading = 1.000), followed by TIM3 (0.791) and TIM2 (0.501), indicating that the team-building character of respondents is primarily reflected in their ability to select appropriate team members. At the same time, the aspects of cohesion and trust,

as well as teamwork processes, continue to provide adequate information support for the representation of latent variables.

Teacher Motivation

The teacher motivation variable consists of five dimensions with eight indicators. The measurement model of teacher motivation variables was analyzed through Confirmatory Factor Analysis (CFA), with the results indicating that the model has a good fit (Figure 8).

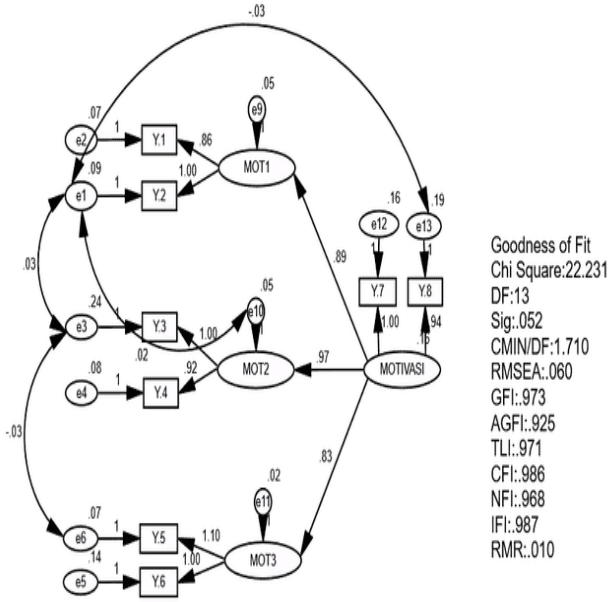

Figure 8. Measurement Model of Teacher Motivation Variable

The Chi-Square value of 22.231 with 13 degrees of freedom (df) and a significance level of 0.052 (> 0.05) indicates that the model is acceptable. Other fit indices support this finding, with CMIN/DF of 1.710 (< 2.00), RMSEA 0.060 (< 0.08), GFI 0.973, AGFI 0.925, TLI 0.971, CFI 0.986, NFI 0.968, IFI 0.987, and RMR 0.010, all of which are in the fit category. These results indicate that indicators Y1–Y8 can consistently reflect the latent construct of teacher motivation through three main dimensions (MOT1, MOT2, and MOT3). These findings provide empirical evidence that the teacher motivation variable has high convergent validity and reliability. Therefore, the measurement instrument used is suitable for analyzing structural models in the context of school entrepreneurial competence.

Table 8. Teacher Motivation Loading Factor Value

Indicator	Coefficient	S.E.	C.R.	P	EXP
MOT1	.894	.108	8.291	***	Valid
MOT2	.968	.137	7.082	***	Valid
MOT3	.833	.106	7.885	***	Valid
MOT4	1.000				Valid
MOT5	.940	.114	8.229	***	Valid

The results of confirmatory factor analysis for the Teacher Motivation construct show that all indicators are valid with loading factors > 0.50 and significant (CR > 1.96; p < 0.001): MOT1 = 0.894 (SE = 0.108; CR = 8.291), MOT2 = 0.968 (SE = 0.137; CR = 7.082), MOT3 = 0.833 (SE = 0.106; CR = 7.885), MOT4 = 1.000 (reference indicator), and

MOT5 = 0.940 (SE = 0.114; CR = 8.229). The measurement equations (MOT1 = 0.894 × Motivation + 0.05; Mot2 = 0.968 × Motivation + 0.05; Mot3 = 0.833 × Motivation + 0.02; Mot4 = 1.000 × Motivation + 0.16; Mot5 = 0.940 × Motivation + 0.19) indicate small to moderate error terms and consistent contributions from the measurers. Substantively, MOT4 (Strength) is the most dominant indicator (loading = 1.000), followed by MOT2 and MOT5, so that the Motivation construct is primarily reflected by motivational strength/constancy, with significant support from intensity, generality, and magnitude. The measurement model, therefore, meets the criteria for convergent validity and is ready for use in structural testing.

Teacher Performance

The teacher performance variable consists of five dimensions with 13 indicators. The measurement model of teacher performance variables was analyzed through Confirmatory Factor Analysis and showed excellent model fit (Figure 9).

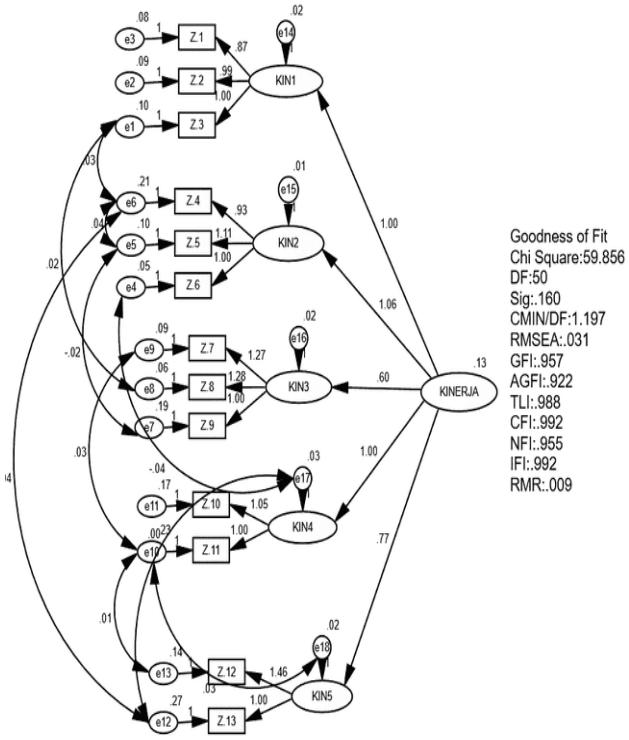

Figure 9. Teacher Performance Variable Measurement Model

The Chi-Square value of 59.856 with 50 degrees of freedom (df) and a significance level of 0.160 (> 0.05) indicates that the model is acceptable. Other fit indices support this result, with CMIN/DF of 1.197 (< 2.00), RMSEA of 0.031 (< 0.08), GFI of 0.957, AGFI of 0.922, TLI of 0.988, CFI of 0.992, NFI of 0.955, IFI of 0.992, and RMR of 0.009, all of which meet the fit criteria.

Table 9. Teacher Performance Loading Factor Value

Indicator	Coefficient	S.E.	C.R.	P	EXP
KIN1	1.000				Valid
KIN2	1.057	.097	10.915	***	Valid
KIN3	.602	.095	6.357	***	Valid
KIN4	1.000	.131	7.630	***	Valid
KIN5	.773	.126	6.127	***	Valid

These results (Table 9) prove that indicators Z1–Z13 consistently reflect the latent construct of teacher performance through five main dimensions (KIN1, KIN2, KIN3, KIN4, and KIN5). Academically, these findings confirm that the teacher performance variable has high convergent validity and reliability, so the measurement instrument used can be declared valid and suitable for structural model analysis to test the relationship between variables in the context of entrepreneurial competence in schools.

Full Model Structural Equation Modeling

The whole model SEM before modification shows the results of the model fit test, which does not fully meet the ideal goodness of fit criteria (Figure 10). After modification, the full SEM model image shows a significant improvement in model fit compared to the previous model.

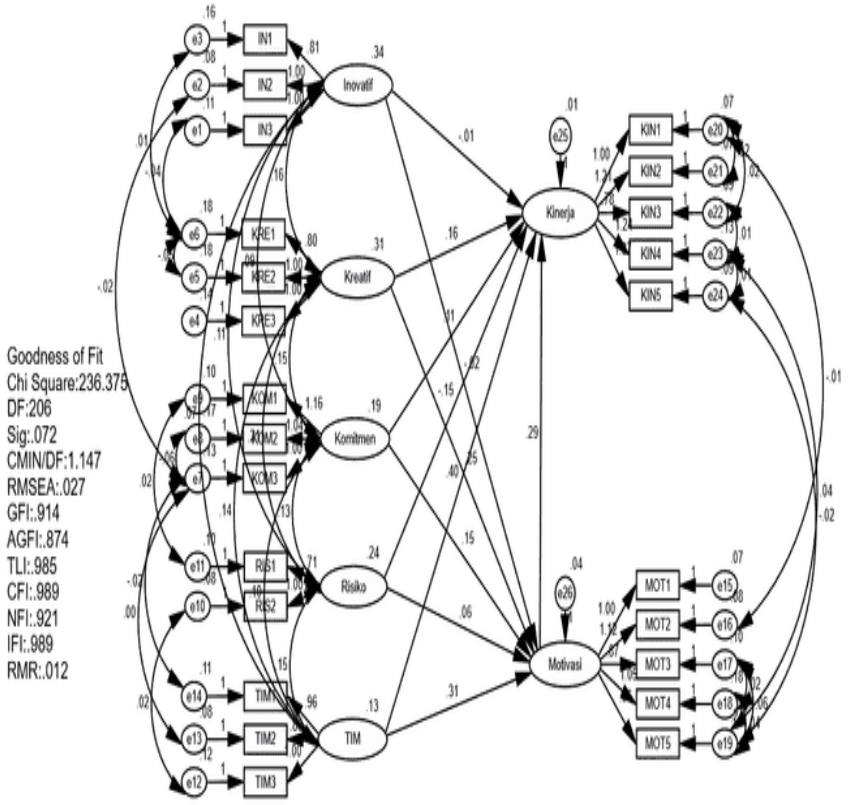

Figure 10. Full Model after Modification

The Chi-Square value of 236.373 with 206 degrees of freedom produces a significance of 0.072 (> 0.05), indicating no significant difference between the sample covariance matrix and the model covariance, so that the model can be accepted. Other goodness-of-fit indices also strengthen these results, with CMIN/DF of 1.147 (< 2.00), RMSEA 0.027 (< 0.08), GFI 0.914, AGFI 0.874, TLI 0.985, CFI 0.989, NFI 0.921, IFI 0.989, and RMR 0.012, most of which are in the good fit category, and the rest are in the marginal fit. These results indicate that the latent constructs of innovative, creative, commitment, risk, and team building can consistently explain teacher motivation and performance variables with high validity and reliability. Academically, these findings confirm that the model modifications successfully increased the estimates' stability and the empirical data's suitability, so that the resulting structural model is suitable for testing the causal relationship between variables in the context of the principal's entrepreneurial competence.

Model Goodness of Fit Test

In the model before modification (Table 10), although some criteria showed good fit such as CMIN/DF (1.742), CFI (0.937), TLI (0.925), IFI (0.938), RMSEA (0.061), and RMR (0.014), other indicators did not meet the requirements, such as the Chi-Square value (402.358; sig. 0.000), GFI (0.855), AGFI (0.812), and NFI (0.866), which were only in the marginal fit or poor fit category. After the modification, there was a significant increase in the model's suitability, indicated by the Chi-Square value (236.375; sig. 0.072) which has met the fit criteria, as well as improvements in almost all indices, such as GFI (0.914), CFI (0.989), TLI (0.985), NFI (0.921), IFI (0.989), RMSEA (0.027), and RMR (0.012), all of which indicate a good fit. However, AGFI (0.874) is still in the marginal fit category. These academic results confirm that the model modification has successfully increased the overall validity and rendered the model suitable for testing structural relationships between variables.

Table 10. Summary of Model Goodness of Fit Test Results

Criteria Goodness of Fit	Analysis Result	Cut of Value	Model Evaluation
1	2	3	4
	Before Modification		
Degree of Freedom (DF)	Positive (+)	231	
X^2 (Chi - Square)	267,455	402,358	Poor
Significance Probability	≥ 0,05	0,000	Poor
CMIN/DF	≤ 2,00	1,742	Fit
GFI	≥ 0,90	0,855	Marginal
AGFI	≥ 0,90	0,812	Marginal
CFI	≥ 0,90	0,937	Fit
TLI	≥ 0,90	0,925	Fit
NFI	≥ 0,90	0,866	Marginal
IFI	≥ 0,90	0,938	Fit
RMSEA	≤ 0.08	0,061	Fit
RMR	≤0,05	0,014	Fit
	After Modification		
Degree of Freedom (DF)	Positive (+)	206	
X^2 (Chi - Square)	240,485	236,375	Fit
Significance Probability	≥ 0,05	0,072	Fit
CMIN/DF	≤ 2,00	1,147	Fit
GFI	≥ 0,90	0,914	Fit
AGFI	≥ 0,90	0,874	Marginal
CFI	≥ 0,90	0,989	Fit
TLI	≥ 0,90	0,985	Fit
NFI	≥ 0,90	0,921	Fit
IFI	≥ 0,90	0,989	Fit
RMSEA	≤ 0.08	0,027	Fit
RMR	≤0,05	0,012	Fit

Structural influence between variables

The estimation results show that teacher motivation (Y) is influenced by five entrepreneurial competence characteristics, namely innovative (X1), creative (X2), commitment (X3), risk-taking (X4), and team building (X5). Team-building (X5; coefficient 0.306) and creative (X2; coefficient 0.247) have the most decisive influence on teacher motivation, followed by commitment (X3; coefficient 0.150) and risk-taking (X4; coefficient 0.055), while innovative (X1; coefficient –0.025) shows a relatively weak negative influence. Furthermore, teacher performance (Z) is influenced by these

five characteristics and teacher motivation (Y). The estimation results show that the most significant direct influence on teacher performance comes from team-building character (X5; coefficient 0.120), followed by risk-taking character (X4; coefficient 0.087), creative character (X2; coefficient 0.063), commitment character (X3; coefficient 0.052), and teacher motivation (Y; coefficient 0.097), while innovative character (X1; coefficient 0.029) provides a relatively small contribution. These results confirm that the role of team-building character and creativity of the principal is more dominant in increasing teacher motivation and performance. In contrast, innovative character does not show a significant contribution in the context of this study.

Table 11. Structural Influence Between Variables

Influence			Coefficient
		X1, X2, X3, X4, X5 → Y	
X1	→	Y	-0,025
X2	→	Y	0,247
X3	→	Y	0,150
X4	→	Y	0,055
X5	→	Y	0,306
		X1, X2, X3, X4, X5, Y → Z	
X1	→	Z	0,029
X2	→	Z	0,063
X3	→	Z	0,052
X4	→	Z	0,087
X5	→	Z	0,120
Y	→	Z	0,097

Note: X1 (Innovative Character), X2 (Creative Character), X3 (Committed Character), X4 (Risk-Taking Character), X5 (Team Building Character), Y (Teacher Motivation), Z (Teacher Performance).

Direct Effect

The direct effect in SEM analysis is determined through significance values and t-tests, which are commonly used in regression analysis. Based on the whole model SEM analysis output in the Appendix, a summary of the causal relationships between the variables in this study can be created, as shown in Table 12.

Table 12. Direct effect

Influence			Coefficient	C.R.	P	EXP
X1	→	Y	-0,025	-0,641	0,522	Not Significant
X2	→	Y	0,247	3,274	0,001	Significant
X3	→	Y	0,150	2,265	0,024	Significant
X4	→	Y	0,055	0,525	0,599	Not Significant
X5	→	Y	0,306	2,272	0,023	Significant
X1	→	Z	-0,011	-0,384	0,701	Not Significant
X2	→	Z	0,165	2,597	0,009	Significant
X3	→	Z	0,106	2,037	0,042	Significant
X4	→	Z	-0,151	-1,735	0,083	Not Significant
X5	→	Z	0,404	3,358	***	Significant
Y	→	Z	0,291	3,002	0,003	Significant

The results show that teacher motivation (Y) is significantly influenced by creative character (X2; coef. 0.247; p = 0.001), commitment character (X3; coef. 0.150; p = 0.024), and team building character (X5; coef. 0.306; p = 0.023), while innovative character (X1; coef. –0.025; p = 0.522) and risk-taking character (X4; coef. 0.055; p = 0.599) do not show a significant influence. Furthermore, teacher performance (Z) is

significantly influenced by creative character (X2; coef. 0.165; p = 0.009), commitment (X3; coef. 0.106; p = 0.042), team building (X5; coef. 0.404; p < 0.001), and teacher motivation (Y; coef. 0.291; p = 0.003). In contrast, innovative character (X1; coef. –0.011; p = 0.701) and risk-taking character (X4; coef. –0.151; p = 0.083) do not significantly influence teacher performance. This finding confirms that the principal's creativity, commitment, and team-building skills play a dominant role in increasing teacher motivation and performance. At the same time, innovation and risk-taking do not contribute significantly to the context of this study.

Mediation

The indirect influence in this study uses the Sobel test, which is presented in Table 13. The results show that only creative character (X2) has a significant effect on teacher performance (Z) through teacher motivation (Y), with a t-count value of 2.164 greater than the t-table of 1.960. This indicates that teacher motivation effectively mediates the relationship between the principal's creative character and teacher performance. In contrast, other variables such as innovative character (X1; t count –0.596), commitment (X3; t count 1.751), daring to take risks (X4; t count 0.490), and team building (X5; t count 1.756) do not show a significant indirect effect through teacher motivation. This finding confirms that principal creativity is a key factor capable of improving teacher performance indirectly by mediating motivation. At the same time, other character dimensions have not been proven to have a significant mediation path.

Table 13. Indirect Influence (Sobel Test)

Relationship	t count	t table	Information
X1 → Y → Z	-0,596	1,960	Not Significant
X2 → Y → Z	2,164	1,960	Significant
X3 → Y → Z	1,751	1,960	Not Significant
X4 → Y → Z	0,490	1,960	Not Significant
X5 → Y → Z	1,756	1,960	Not Significant

Simultaneous Effects

The simultaneous test in this study was used to determine the concurrent effects of innovative, creative, committed, risk-taking, and team-building traits on teacher motivation and performance. The results of the simultaneous test are presented in Table 14.

Table 14. Simultaneous Effects

Simultaneous Effects	F count	F table	R Square	Information
X1, X2, X3, X4, X5→ Y	93,173	2,259	0,706	Significant
X1, X2, X3, X4, X5, Y → Z	296,065	2,144	0,902	Significant

The results of the simultaneous influence analysis between variables, which show that together the innovative (X1), creative (X2), commitment (X3), risk-taking (X4), and team-building (X5) characters have a significant effect on teacher motivation (Y), with a calculated F value of 93.173 greater than the F table of 2.259 and an R Square value of 0.706, which means that these five characters can explain 70.6% of the variation in teacher motivation. Furthermore, when the teacher motivation variable (Y) is entered together with the five entrepreneurial characters to predict teacher performance (Z), the results are also significant with a calculated F of 296.065 greater than the F table of 2.144, and an R Square value of 0.902. This indicates that the

combination of innovative, creative, commitment, risk-taking, team building, and teacher motivation characteristics can explain 90.2% of the variation in teacher performance. This finding confirms that the research model has strong predictive power, where the principal's entrepreneurial competence variables contribute significantly to increasing teacher motivation and performance.

Discussion

Research findings indicate that team building is the most dominant dimension influencing teacher performance, both directly and indirectly through work motivation. These results confirm that the principal's ability to build cooperation, establish trust, and foster group cohesion is a key determinant of school organizational success. Within the framework of collective efficacy theory, effective collaboration creates mutual trust and clarity of shared goals, ultimately increasing teacher work efficiency and professional commitment (Ramadhani et al., 2022; Yalçın et al., 2025). This principle aligns with findings from capacity-building theory, which emphasizes that collaborative leadership strengthens individual and institutional capacity through continuous professional development (Sinaga et al., 2021; Zhang, 2022).

Practically, the dominant effect of team building explains the psychological mechanisms by which a collaborative work culture facilitates open communication, collective learning, and goal alignment among teachers. Thus, the principal's ability to build teams is not merely a coordinating function but also a strategic instrument for building collective efficacy and clarity of direction in achieving school goals.

The creativity dimension has a significant influence on teacher motivation and performance, both directly and through its mediating effect on work motivation. These results confirm that creative leadership plays a role in stimulating pedagogical innovation and encouraging teacher engagement in developing learning practices. From a transformational leadership perspective, principal creativity aligns with the concept of intellectual stimulation, specifically the leader's ability to challenge long-held assumptions, create space for exploring new ideas, and encourage innovative problem-solving (En, 2023; Zou et al., 2023).

Creativity also enhances intrinsic motivation, as teachers feel valued for their contributions of ideas and creativity. This strengthens work motivation through psychological mechanisms such as satisfaction with autonomy and professional engagement (Pinkas, 2021). This effect explains why principal creativity has a direct influence on performance and also acts as a motivational driver in the context of vocational high schools.

The commitment dimension showed a significant effect, although with a relatively smaller magnitude compared to creativity and teamwork. In the context of educational organizations, principal commitment reflects affective dedication and normative responsibility to the school's mission. This condition is more influential in environments with high organizational stability and strong interpersonal relationships, where the loyalty and consistency of leader behavior serve as moral examples for teachers. Principal commitment fosters affective bonds and emotional trust between leaders and teachers (Çoban et al., 2020; Mutohar & Trisnantari, 2020).

Theoretically, these results support the perspective of affective commitment theory, which states that a leader's emotional attachment to the organization influences the work behavior of their subordinates. In the context of vocational

education, principal commitment plays a crucial role in maintaining stable teacher motivation amidst administrative challenges and industry demands.

Although innovation and risk-taking are theoretically important aspects of entrepreneurial competency, research findings indicate that neither significantly impacts teacher motivation and performance. This finding aligns with previous empirical evidence that in highly regulated and resource-constrained education systems, risk-taking and innovative behavior are often hampered by bureaucracy, limited school autonomy, and cultural resistance to change (Maleki, 2024; Warda et al., 2025).

As explained by Tan et al. (2020) and Nelson et al. (2024), principals' efforts to innovate often fail to have a significant impact on supervision or instructional practices if an open and adaptive organizational culture does not support them. This situation reflects the contextual reality of vocational schools in Indonesia, which still rely on centralized policies and lack space for experimentation. Therefore, efforts to increase the dimensions of innovation and risk-taking in school leadership need to be accompanied by policy reforms that strengthen school autonomy and institutional readiness (Khurniawan et al., 2020; Priyana et al., 2024; Syarifuddin, 2024).

The results of the mediation analysis indicate that teacher work motivation serves as a significant mediator in the relationship between principals' entrepreneurial competencies and teacher performance. This mechanism can be explained through the concept of professional growth, engagement, and performance, where increased internal motivation leads to higher work engagement, ultimately improving performance (Mas et al., 2023). Work motivation acts as a "psychological bridge" between leadership behavior and teacher performance outcomes, consistent with self-determination and capacity-building theories (Sinaga et al., 2021; Zhang, 2022). Thus, motivation is not only a derivative effect of entrepreneurial leadership but also a key mechanism explaining the transfer of influence from principal behavior to teacher performance.

Several previous studies support these empirical findings. Entrepreneurial leadership behaviors such as inspirational motivation and intellectual stimulation have been found to strengthen teacher commitment and intrinsic motivation (En, 2023; Zou et al., 2023). Principals who foster a collaborative and empowering school culture also enhance collective efficacy and drive better performance among teachers (Ramadhani et al., 2022; Yalçın et al., 2025). (Pinkas, 2021) further asserts that a positive organizational climate cultivated through entrepreneurial leadership directly improves teacher motivation. Complementary studies show that teacher supervision, mentoring, and professional development initiatives led by principals contribute directly to performance improvement (Sinaga et al., 2021; Zhang et al., 2022). Similarly, managerial and instructional competencies have been identified as key factors supporting teachers' professional growth (Mutohar & Trisnantari, 2020)Çoban et al., 2020).

Nonetheless, some inconsistencies emerge concerning the influence of innovation and risk-taking. Although theoretically integral to entrepreneurial competence, these dimensions did not significantly affect teacher motivation or performance in this study. This finding aligns with prior evidence suggesting that in tightly regulated and resource-limited school systems, risk-taking behaviors are often constrained and undervalued (Maleki, 2024; Warda et al., 2025). Likewise, principals' innovative initiatives may fail to translate into measurable instructional or

supervisory improvements without a supportive organizational culture (Tan et al., 2020) (Nelson et al., 2024). These contextual limitations highlight the importance of institutional readiness and cultural openness in translating entrepreneurial traits into practical educational leadership outcomes.

Theoretically, these findings reinforce multiple leadership frameworks. From the transformational leadership perspective, principals' inspirational behaviors and intellectual stimulation foster teachers' commitment and innovative drive (En, 2023; Zou et al., 2023). According to collective efficacy theory, a school culture that promotes collaboration and shared goals mediates the relationship between leadership and teacher performance (Ramadhani et al., 2022; Yalçın et al., 2025). The capacity-building theory supports the notion that principals enhance teacher competence through continuous training, supervision, and professional development (Sinaga et al., 2021; Zhang et al., 2022). Furthermore, the resource mobilization theory in entrepreneurial leadership posits that competent principals can create sustainable and productive school-based enterprises that enhance teacher welfare and motivation (Kamsidik, 2024; Shi et al., 2022).

Overall, the results of this study indicate that entrepreneurial leadership plays a strategic role in improving teacher motivation and performance, primarily through goal clarity, collaborative culture, professional growth, and resource utilization. However, innovation and risk-taking dimensions require further attention in practice, given their contextual constraints. These findings imply that leadership development programs should emphasize creativity, commitment, and team-building skills, while educational policies should strengthen school, industry partnerships and provide greater support for teacher empowerment (Khurniawan et al., 2020; Mas et al., 2023; Priyana et al., 2024; Syarifuddin, 2024).

This study has several methodological limitations that should be considered:

- Clustering effect (clustered data): Since teachers are in different schools, there may be effects between groups. Further analysis using multilevel SEM (MSEM) is recommended to deepen cross-level understanding.
- Cross-sectional design: This design does not allow for longitudinal causal inference. Future studies should employ a longitudinal or quasi-experimental design to examine the dynamics of teacher motivation and performance over time.
- Self-report data: All data are obtained from teacher perceptions, so the potential for standard method bias remains despite procedural and statistical controls (Harman's test). The use of multi-source data (principal-teacher dyads) is recommended to reduce perception bias.
- Lack of objective metrics: Teacher performance is often measured through perceptions rather than quantitative indicators, such as student learning outcomes. Future research could add objective performance metrics to strengthen external validity.

CONCLUSION

This study aims to empirically examine how principal competency influences teacher work motivation and performance in vocational high schools, and to examine the role of work motivation as a mediator between the two. The model developed through Structural Equation Modeling (SEM) analysis demonstrated an excellent fit and substantially explained most of the variation in teacher motivation and performance. The results indicate that three main dimensions of entrepreneurial

competency, creativity, commitment, and team-building skills, play the strongest role in improving teacher motivation and performance. All three contribute both directly and indirectly through increased work motivation. These findings confirm that collaborative, creative, and goal-oriented leadership can enhance collective efficacy and foster a professional spirit within the school environment. Conversely, the dimensions of innovation and risk-taking had no significant impact on motivation and performance. This situation highlights the limitations of school autonomy and the persistent regulatory constraints in vocational education, where opportunities for experimentation and independent decision-making remain relatively limited. Thus, the effectiveness of entrepreneurial leadership depends heavily on institutional readiness and policy support that foster managerial resilience at the school level. Overall, this study suggests that teacher work motivation is a key psychological mechanism that bridges the influence of principal competence on performance improvement. Principals who can create a collaborative work environment and provide intellectual stimulation will be more effective in fostering teachers' intrinsic motivation to innovate and achieve.

RECOMMENDATION

Based on the research findings, it is recommended that vocational school principals strengthen the proven dimensions of entrepreneurial competency, particularly creativity, commitment, and team-building skills, by implementing leadership strategies that encourage collaboration, participation, and teacher empowerment. Furthermore, ongoing training programs are needed for principals to increase their capacity to develop more measurable learning innovations and risk management. Policymakers in vocational education are expected to provide adequate resources, incentives, and facilities to encourage professional teacher development. Further research is recommended to explore the role of external factors such as education policy, industry involvement, and community support in strengthening the influence of principals' entrepreneurial competency on teacher motivation and performance.

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Data Availability
Data availability is not applicable to this article because no new data were created or analyzed in this study.

Author Contributions Statement

Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
Sri Hastati	✓	✓	✓	✓	✓	✓		✓	✓	✓			✓	
Abdul Wahid		✓		✓		✓		✓		✓		✓		✓
Nur Afni	✓		✓	✓			✓			✓	✓		✓	✓

C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

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APPENDIX

Table A1. Measurement Blueprint (Construct → Sample item wording → Source → Scale anchors → Adaptation/translation steps)

Construct / Dimension (codes)	Sample item wording (representative)	Source (instrument origin)	Scale anchors	Adaptation / translation & refinement steps
Principals' Entrepreneurial Competence – Innovation (IN1–IN3)	"The principal generates, develops, and implements new ideas to improve the school."	Permendiknas No. 13/2007; entrepreneurship/educational leadership literature (e.g., Weber & Foll, 2020; Çamur & Göğüş, 2023)	5-point Likert (1 = Strongly disagree to 5 = Strongly agree)	Construct specification from regulation & key literature → item drafting in Indonesian aligned to SMK context → expert content validation (substantive + language) → pilot test (outside main sample) → CFA-based refinement (CB-SEM) retaining stable indicators (IN1–IN3).
Principals' Entrepreneurial Competence – Creativity (CRE1–CRE3)	"The principal proposes original solutions and encourages creative problem-solving in school management."	Permendiknas No. 13/2007; supporting entrepreneurship/leadership studies	5-point Likert (SD–SA)	Contextualized wording for vocational schools → expert review for clarity and relevance → pilot test → CFA retained 3 core creativity indicators reflecting divergent thinking and originality.
Principals' Entrepreneurial Competence – Commitment (COM1–COM3)	"The principal demonstrates persistence, responsibility, and consistency in pursuing the school vision."	Permendiknas No. 13/2007; leadership/organizational commitment literature used in the dissertation development	5-point Likert (SD–SA)	Initial item bank in dissertation included broader commitment facets (e.g., pride, willingness to contribute; some favourable/unfavourable items) → expert validation to ensure semantic equivalence → pilot test reliability screening → CFA in the article stage retained 3 most representative indicators (COM1–COM3).
Principals' Entrepreneurial Competence – Risk-taking (RIS1–RIS2)	"The principal is willing to make calculated decisions under uncertainty and is prepared to face risks."	Permendiknas No. 13/2007; entrepreneurship education literature	5-point Likert (SD–SA)	Broader risk-taking indicators in dissertation (e.g., competition readiness, anticipatory decision-making) → contextual rewording to school setting → expert review + pilot test → CFA condensed to 2 most stable indicators (RIS1–RIS2).
Principals' Entrepreneurial Competence – Team-building	"The principal builds trust, selects team members	Permendiknas No. 13/2007; collaboration/team leadership literature	5-point Likert (SD–SA)	Items tailored to school collaboration culture → expert validation → pilot test → CFA retained three

Construct / Dimension (codes)	Sample item wording (representative)	Source (instrument origin)	Scale anchors	Adaptation / translation & refinement steps
(TEAM1–TEAM3)	effectively, and strengthens teamwork among teachers."			indicators representing selecting members–trust–cohesion (TEAM1–TEAM3).
Teacher Work Motivation (MOT1–MOT5)	"I have strong and consistent drive to achieve the best work outcomes at school."	Oli (2024); Pinkas (2021)	5-point Likert (SD–SA)	Translation/adaptation to Indonesian teacher work context → expert review to ensure relevance and clarity → pilot test → CFA retained 5 indicators capturing strength/intensity/goal orientation/consistency of motivation (MOT1–MOT5).
Teacher Performance (KIN/PER1–KIN/PER5)	"I demonstrate high work quality, task accuracy, initiative in improving instruction, technical teaching skills, and professional communication."	Sinaga et al. (2021); Mutohar & Trisnantari (2020)	5-point Likert (SD–SA)	Dissertation stage used a broader item pool → reduced to minimize respondent burden while preserving indicator coverage → expert validation + pilot test → CFA retained 5 core performance indicators (KIN/PER1–KIN/PER5).

Table A2. Endogenous Constructs

Construct (codes)	Sample item wording (representative)	Source (instrument origin)	Scale anchors	Adaptation / translation & refinement steps
Teacher Work Motivation (MOT1–MOT5)	"I have a strong and consistent drive to achieve the best work outcomes at school."	Oli (2024); Pinkas (2021)	5-point Likert (1 = Strongly disagree to 5 = Strongly agree)	Items were adapted to the Indonesian vocational teacher context (SMK) through contextual wording adjustments while preserving the intended meaning → expert content validation (substance and language) → pilot testing outside the main sample to ensure clarity and response stability → CFA-based refinement (CB-SEM) to retain the most representative indicators (MOT1–MOT5) reflecting strength/intensity, goal orientation, and consistency of motivation.
Teacher Performance (KIN/PER1–KIN/PER5)	"I demonstrate high work quality, accuracy in completing tasks, initiative to improve instruction, strong technical teaching skills, and professional communication."	Sinaga et al. (2021); Mutohar & Trisnantari (2020)	5-point Likert (1 = Strongly disagree to 5 = Strongly agree)	A broader initial item pool documented in the dissertation was reduced to minimize respondent burden while maintaining coverage of core performance facets → expert validation ensured relevance to SMK teaching tasks → pilot testing screened readability and internal consistency → CFA (CB-SEM) retained five stable indicators (KIN/PER1–KIN/PER5) aligned with quality, accuracy, initiative, technical competence, and professional communication.

Table 3A. Normality Data Test Results

Variabel	min	max	skew	c.r.	kurtosis	c.r.
PER5	2.250	5.000	-.325	-1.874	-.362	-1.045
PER4	2.000	5.000	-.201	-1.159	-.086	-.248
PER3	3.083	5.000	-.219	-1.265	-.482	-1.391
PER2	3.182	5.000	-.243	-1.401	-1.096	-3.164
PER1	3.333	5.000	-.243	-1.404	-.972	-2.807
MOT5	2.000	5.000	-.331	-1.912	.282	.813
MOT4	2.500	5.000	-.108	-.622	-.194	-.560
MOT3	3.000	5.000	-.270	-1.559	-.240	-.694
MOT2	2.667	5.000	-.301	-1.740	-.268	-.775
MOT1	3.143	5.000	-.227	-1.311	-.933	-2.694
TEAM1	2.833	5.000	-.363	-2.094	-.110	-.319
TEAM2	3.000	5.000	-.390	-2.253	-.002	-.005
TEAM3	2.500	5.000	-.376	-2.171	.168	.484
RIS1	2.778	4.889	-.142	-.817	-.391	-1.129
RIS2	2.200	5.000	-.294	-1.695	.018	.051
COM1	2.000	5.000	-.092	-.529	-.525	-1.515
COM2	1.667	5.000	.122	.703	-.030	-.086
COM3	2.333	5.000	-.376	-2.173	-.497	-1.434
CRE1	2.556	5.000	-.340	-1.965	-.899	-2.595
CRE2	1.667	5.000	-.346	-1.995	-.673	-1.942
CRE3	2.333	5.000	-.222	-1.283	-.961	-2.775
IN1	2.333	5.000	-.321	-1.856	-.441	-1.273
IN2	2.000	5.000	-.230	-1.327	-.881	-2.543
IN3	1.500	5.000	-.251	-1.446	-.354	-1.022
Multivariate					43.108	8.629

Table 4A. Outlier Test Results

Observation number	Mahalanobis d-squared	p1	p2
1	1	3	4
168	51.984	.001	.011
91	48.996	.002	.007
109	46.836	.004	.006
24	45.415	.005	.004
187	43.251	.009	.012
67	42.762	.011	.006
7	42.695	.011	.002
99	42.235	.012	.001
173	40.869	.017	.003
9	40.650	.018	.001
34	40.394	.019	.001
20	39.731	.023	.001
32	38.924	.028	.002
31	38.796	.029	.001
147	38.537	.031	.000
64	38.187	.033	.000
21	37.972	.035	.000
170	37.552	.039	.000
28	37.541	.039	.000
83	37.443	.039	.000
18	37.036	.043	.000
163	36.073	.054	.001
174	35.598	.060	.001
40	35.592	.060	.000
138	35.149	.066	.001
27	35.116	.067	.000
38	34.594	.075	.001
57	34.412	.078	.001
126	34.411	.078	.000
45	34.032	.084	.001

Table 5A. Convergent Validity Test Result

Indicator			Estimate
IN3	<---	Innovative	0,874
IN2	<---	Innovative	0,902
IN1	<---	Innovative	0,761
CRE3	<---	Creative	0,826
CRE2	<---	Creative	0,794
CRE1	<---	Creative	0,721
COM3	<---	Commitment	0,768
COM2	<---	Commitment	0,742
COM1	<---	Commitment	0,846
RIS2	<---	Risk	0,863
RIS1	<---	Risk	0,740
TEAM3	<---	Team	0,732
TEAM2	<---	Team	0,751
TEAM1	<---	Team	0,722
MOT1	<---	Motivation	0,805
MOT2	<---	Motivation	0,809
MOT3	<---	Motivation	0,700
MOT4	<---	Motivation	0,662
MOT5	<---	Motivation	0,523
PER1	<---	Peformance	0,731
PER2	<---	Peformance	0,806
PER3	<---	Peformance	0,617
PER4	<---	Peformance	0,708
PER5	<---	Peformance	0,799

Table 6A. Average Variance Extracted Test Result

Construct	CR	AVE	√AVE
Innovative	0.903	0.848	0.921
Creative	0.886	0.782	0.884
Commitment	0.872	0.751	0.867
Risk Taking	0.854	0.732	0.856
Team Building	0.879	0.788	0.888
Motivation	0.918	0.708	0.841
Performance	0.854	0.735	0.857